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TRANSACTIONS

OF THE

AMERICAN SURGICAL ASSOCIATION

ROYAL SOCIETY OF MEDICINE
JUN 5
1924

VOLUME THE FORTY-FIRST

EDITED BY

JOHN H. JOPSON, M.D.

RECORDER OF THE ASSOCIATION

PRINTED FOR THE ASSOCIATION

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1923

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PHILADELPHIA

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OFFICERS OF THE ASSOCIATION

ELECTED JUNE, 1923

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HOMER GAGE, M.D.

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ROBERT B. GREENOUGH, M.D.,
8 Marlborough Street, Boston, Mass.

TREASURER

CHARLES H. PECK, M.D.,
30 West Fiftieth Street, New York City.

RECORDER

JOHN H. JOPSON, M.D.,
1824 Pine Street, Philadelphia, Pa.

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ROBERT B. GREENOUGH, M.D.
CHARLES H. PECK, M.D.
JOHN H. JOPSON, M.D.

Ex-officio.

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RECORDER, SECRETARY AND TREASURER, *ex-officio.*

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PRESIDENT, SECRETARY, RECORDER AND THE CHAIRMAN OF THE ADJUNCT LOCAL COMMITTEE OF ARRANGEMENTS, *ex-officio.*

COMMITTEE ON ARCHIVES

(Report by Title.)

CHARLES N. DOWD, M.D., *Chairman*
ASTLEY P. C. ASHHURST, M.D.
LINCOLN DAVIS, M.D.

Place of next meeting:

BALTIMORE, MD.

ADJUNCT LOCAL COMMITTEE OF ARRANGEMENTS

JOSEPH C. BLOODGOOD, M.D.
WILLIAM A. FISHER, M.D.

LIST OF THE PRESIDENTS

OF THE

ASSOCIATION FROM THE TIME OF ITS INSTITUTION

ELECTED

1880. ‡SAMUEL DAVID GROSS, M.D., LL.D., D.C.L. (Oxon.), LL.D. (Cantab.), LL.D. (Edin.)—Founder of the Association.
1883. ‡EDWARD MOTT MOORE, M.D., LL.D.
1884. ‡WILLIAM THOMPSON BRIGGS, M.D.
1885. ‡MOSES GUNN, A.M., M.D., LL.D.
1886. ‡HUNTER McGUIRE, M.D., LL.D.
1887. ‡D. HAYES AGNEW, M.D., LL.D.
1888. ‡DAVID WILLIAMS CHEEVER, M.D., LL.D.
1889. ‡DAVID W. YANDELL, M.D.
1890. ‡CLAUDIUS HENRY MASTIN, M.D., LL.D.
1891. ‡PHINEAS SANBORN CONNER, M.D., LL.D.
1892. ‡NICHOLAS SENN, M.D., Ph.D., LL.D.
1893. ‡JAMES EWING MEARS, A.M., M.D., LL.D.
1894. FREDERIC SHEPARD DENNIS, M.D.
1895. ‡LOUIS McLANE TIFFANY, A.M. (Cantab.), M.D.
1896. JOHN COLLINS WARREN, M.D., LL.D. (Jefferson) Hon. F.R.C.S. (Eng.).
1897. ‡THEODORE F. PREWITT, M.D.
1898. WILLIAM W. KEEN, A.M., M.D., LL.D., Hon. F.R.C.S. (Eng., Edin. and Ireland), Hon. F.A.C.S.
1899. ROBERT F. WEIR, A.M., M.D., Hon. F.R.C.S. (Eng.).
1900. ‡ROSWELL PARK, M.D.
1901. ‡DE FOREST WILLARD, A.M., M.D., Ph.D.
1902. ‡MAURICE H. RICHARDSON, A.B., M.D.
1903. ‡NATHANIEL P. DANDRIDGE, M.D.
1904. ‡GEORGE BEN JOHNSTON, M.D.
1905. ALBERT VANDER VEER, M.D.
1906. ‡DUDLEY P. ALLEN, M.D., LL.D.
1907. WILLIAM H. CARMALT, M.D.
1908. ‡C. B. G. de NANCRÈDE, A.M., M.D., LL.D.

‡ Deceased.

ELECTED

1909. RUDOLPH MATAS, M.D.
1910. RICHARD H. HARTE, M.D.
1911. ‡ARPAD G. GERSTER, M.D., CHIR.D.
1912. ‡CHARLES A. POWERS, A.M., M.D.
1913. WILLIAM J. MAYO, A.M., M.D., D.SC., F.R.C.S. (EDIN.), LL.D. (TOR.).
1914. GEORGE E. ARMSTRONG, C.M., M.D.
1915. ROBERT G. LE CONTE, A.B., M.D.
1916. SAMUEL J. MIXTER, S.B., M.D.
1917. THOMAS W. HUNTINGTON, A.B., M.D., LL.D.
1918. LEWIS S. PILCHER, A.M., M.D., LL.D.
1919. GEORGE E. BREWER, M.D.
1920. JOHN B. ROBERTS, M.D.
1921. JOHN M. T. FINNEY, M.D.
1922. L. L. MCARTHUR, M.D.
1923. GEORGE W. CRILE, M.D.

‡ Deceased.

NOTICE

This volume of TRANSACTIONS contains the papers read before the Association at the Meeting held May 31 and June 1 and 2, 1923.

The Association assumes no responsibility for the statements and opinions published in this volume.

FELLOWS

OF THE

AMERICAN SURGICAL ASSOCIATION

MAY, 1923

* Denotes Original Fellows.
† Denotes Senior Fellows.
‡ Denotes Deceased Fellows.

ELECTED

†1890. ABBE, ROBERT, M.D., 13 West Fiftieth Street, New York. Senior Surgeon to St. Luke's Hospital. *Vice-President*, 1901. *Council*, 1908.

1902. ANDREWS, E. WYLLYS, A.M., M.D., *Vice-President*, 122 S. Michigan Avenue, Chicago, Ill. Professor of Surgery, Northwestern University Medical School; Surgeon to St. Luke's Hospital and Michael Reese Hospital; Surgeon-in-Chief to Cook County Hospital; Consulting Surgeon to the Provident Hospital.

1916. ARCHIBALD, EDWARD WILLIAM, B.A., M.D., C.M., 52 Westmount Boulevard, Montreal, Canada. Lecturer in Clinical Surgery, McGill University; Assistant Surgeon, Royal Victoria Hospital; Associate Surgeon, Children's Memorial Hospital.

†1901. ARMSTRONG, GEORGE E., M.D., C.M., C.M.G., LL.D. (Queens), D.Sc. (Liverpool), 320 Mountain Street, Montreal. Professor of Surgery and of Clinical Surgery, McGill University; Chief Surgeon to the Royal Victoria Hospital, Consulting Surgeon to the Montreal General Hospital, the Western Hospital and to the Protestant Hospital for the Insane, Verdun; Colonel, C.A.M.C. *President*, 1914.

ELECTED

1913. Ashhurst, Astley Paston Cooper, A.B., M.D., N. E. Corner Sixteenth and Spruce Streets, Philadelphia. Professor of Clinical Surgery in the University of Pennsylvania; Surgeon to the Episcopal Hospital; Surgeon to the Philadelphia Orthopædic Hospital and Infirmary for Nervous Diseases; Colonel, Medical Reserve Corps, U. S. Army.

1922. Bailey, Fred Warren, B.Sc., M.D., 611 Metropolitan Building, St. Louis, Mo. Associate Professor of Surgery, St. Louis University School of Medicine; Surgeon to St. John's Hospital; Visiting Surgeon, St. Louis City Hospital.

1920. Balch, Franklin G., A.M., M.D., F.A.C.S., 279 Clarendon Street, Boston, Mass. Chief of East Surgical Service, Massachusetts General Hospital; Surgeon at the Faulkner Hospital; Associate in Surgery, Graduate Courses in Medicine, Harvard Medical School.

1917. Balfour, Donald, Church, M.B., M.D., Rochester, Minn., Associate Professor of Surgery, University of Minnesota; Surgeon to St. Mary's Hospital, Rochester. *Vice-President*, 1922.

1906. Barrow, David, M.D., 148 Market Street, Lexington, Ky. Surgeon to St. Joseph and Good Samaritan Hospitals; recently, Lieut.-Col., M.C.; Commanding Officer, Base Hospital 40.

†1882. Barton, James M., A.M., M.D., 32 North New Hampshire Ave., Atlantic City, N. J.

1915. Besley, Frederic A., M.D., F.A.C.S., 104 South Michigan Avenue, Chicago, Ill. Professor of Surgery, Northwestern University Medical School; Attending Surgeon to the Mercy and Cook County Hospitals.

1900. Bevan, Arthur Dean, M.D., 122 S. Michigan Boulevard, Chicago. Professor and Head of the Department of Surgery, Rush Medical College, University of Chicago; Surgeon to Presbyterian Hospital.

†1901. Binnie, J. F., M.A., M.B., C.M. (Aberdeen), 917 Rialto Building, Kansas City, Mo. *Vice-President*, 1907 and 1919.

1918. Blair, Vilray Papin, M.D., 4654 Pershing Avenue., St. Louis, Mo. Professor of Oral Surgery, Washington University Dental School; Associate in Surgery, Washington University Medical School; Visiting Surgeon, St. Luke's Hospital; Assistant Surgeon in St. Louis Children's Hospital and Barnes Hospital.

ELECTED

†1906. Blake, John Bapst, A.M., M.D., 311 Beacon Street, Boston, Mass. Assistant Professor in Surgery, Harvard Medical School; Surgeon-in-Chief to the Boston City Hospital; Consulting Surgeon to Long Island Hospital; Consulting Surgeon to Boston Insane Hospital; Consulting Surgeon to the Reformatory for Women, Framingham, Mass.

†1902. Blake, Joseph A., M.D., 116 East Fifty-third Street, New York, N. Y.

1901. Bloodgood, Joseph Colt, B.S. (Wisc., 1888), M.D. (Penna., 1891); office, 904 N. Charles Street, Baltimore, Md.; residence, 18 Midvale Road, Roland Park, Md. Associate Professor of Clinical Surgery, Johns Hopkins University; Surgeon to St. Agnes's Hospital, Baltimore.

1913. Bottomley, John T., A.B., LL.D., M.D., 165 Beacon Street, Boston. Surgeon-in-Chief, Carney Hospital.

†1890. Bradford, Edward Hickling, A.B., M.D., 133 Newbury Street, Boston. Surgeon to the Children's and the Samaritan Hospitals; Assistant Professor of Orthopedic Surgery, Harvard University.

1900. Brewer, George Emerson, M.D., 16 East Sixty-fourth Street, New York City. Emeritus Professor of Surgery in College of Physicians and Surgeons, Columbia University; Consulting Surgeon to the Presbyterian Hospital, Roosevelt, City, Woman's, St. Vincent's, Manhattan Eye, Ear, Nose and Throat Hospitals, and to the Ophthalmic and Aural Institute, New York; to the Muhlenberg Hospital of Plainfield, N. J., the Flushing and Perth Amboy Hospitals. *Vice-President*, 1913. *President*, 1919.

1917. Brewster, George W. W., A.B., M.D., F.A.C.S., 213 Beacon Street, Boston, Mass. Associate in Surgery, Harvard Graduate School; Visiting Surgeon, Massachusetts General Hospital; Consulting Surgeon to Frost Hospital, Chelsea, Mass.; Leonard Morse Hospital, Natick, Mass.; Milford Hospital, Milford, Mass.

1915. Brinsmade, W. B., A.B., M.D., 172 Clinton St., Brooklyn, N. Y. Consulting Surgeon to St. Christopher's Hospital; Senior Surgeon, Brooklyn Hospital; Commander, U.S.N.R.F., M.C.

1911. Bruce, Herbert A., M.D. (Toronto Univ.), L.R.C.P. (London), F.R.C.S. (England), 64 Bloor Street East, Toronto, Canada. Professor of Clinical Surgery, University of Toronto; Surgeon to the Toronto General Hospital;

ELECTED

Colonel, Canadian Army Medical Corps and Royal Army Medical Corps; Late Consulting Surgeon to the British Armies in France.

1911. Buchanan, J. J., A.M., M.D., Ph.D., 1409 N. Highland Avenue, Pittsburgh, Pa. Emeritus Professor of Surgery, University of Pittsburgh; Surgeon to Mercy Hospital.

1900. Bunts, Frank E., M.D., Euclid Avenue and Ninety-third Street, Cleveland, Ohio. Professor of Principles of Surgery and Clinical Surgery in Medical College of Western Reserve University; Visiting Surgeon and Chief of Staff to St. Vincent's Charity Hospital.

1921. Campbell, William Francis, A.B., M.D., F.A.C.S., 394 Clinton Avenue, Brooklyn, N. Y. Emeritus Professor of Surgery, Long Island College Hospital; Surgeon-in-Chief to the Trinity Hospital; Consulting Surgeon to the Methodist Episcopal, East New York and Brownsville, Long Island College, Coney Island, Swedish, Jamaica, and Zion Hospitals.

†1885. Carmalt, William H., A.M., M.D., 261 St. Ronan Street, New Haven, Conn. Emeritus Professor of Surgery in Yale University; President and Consulting Surgeon to the New Haven Hospital. *President*, 1907; *Vice-President*, 1895; *Member of Council*, 1908.

1909. Carrel, Alexis, L.B., Sc.B., M.D., Rockefeller Institute for Medical Research, Sixty-sixth Street and Avenue A, New York, N. Y. *Vice-President*, 1919.

†1896. Carson, Norman Bruce, M.D., 303 Humboldt Building, St. Louis, Mo. Surgeon to St. Louis, Mullanphy Hospital and to the St. Vincent Insane Asylum, etc. *Vice-President*, 1903.

1922. Cheever, David, A.B., M.D., Peter Bent Brigham Hospital, Boston, Mass. Assistant Professor of Surgery and Associate in Anatomy, Harvard Medical School; Surgeon to the Peter Bent Brigham Hospital.

1920. Clinton, Marshall, M.D., 556 Franklin Street, Buffalo, New York. Associate Professor of Surgery, University of Buffalo, Department of Medicine; Professor of Oral Surgery, University of Buffalo, Dental Department; Attending Surgeon, Buffalo General, Erie County, and Buffalo City Hospitals.

ELECTED

1920. Clopton, Malvern Bryan, M.D., 405 Humboldt Building, St. Louis, Mo. Associate in Surgery, Washington University Medical School; Visiting Surgeon, St. Luke's Hospital; Assistant Surgeon, Barnes Hospital; Associate Surgeon, St. Louis Children's Hospital.

1916. Codman, Ernest Amory, A.B., M.D., 227 Beacon Street, Boston, Mass.

1898. Coley, William B., M.D., 6 West Fiftieth Street, New York. Attending Surgeon to the Memorial Hospital; Associate Surgeon to the Hospital for Ruptured and Crippled, New York.

1922. Connors, John Fox, A.M., M.D., 59 East Fifty-fourth Street, New York City. Surgical Director, Harlem Hospital; Surgeon to the Washington Square Hospital; Consulting Surgeon, St. Mary's Hospital, Waterbury, Conn.

1914. Cotton, Frederick J., A.B., M.D., A.M., 520 Commonwealth Avenue, Boston, Mass. Visiting Surgeon to the Boston City Hospital; Associate in Surgery, Harvard School for Graduate Instruction in Medicine; Consultant in Surgery, United States Public Health Service, Northeastern District; also Consultant in Surgery, New England Hospital for Women and Children.

1905. Crile, George W., M.D., *President*, Euclid Avenue and Ninety-third Street, Cleveland, Ohio. Professor of Surgery, School of Medicine, Western Reserve University; Visiting Surgeon to Lakeside Hospital.

1906. Cushing, Harvey, A.M., M.D., Sc.D., LL.D., F.R.C.S., The Peter Bent Brigham Hospital, Boston. Professor of Surgery, Harvard University.

†1896. Cushing, Hayward Warren, A.B., M.D., 70 Commonwealth Avenue, Boston, Mass. Consulting Surgeon, Boston City Hospital.

†1897. Da Costa, John Chalmers, M.D., 2045 Walnut Street, Philadelphia. Samuel D. Gross Professor of Surgery, Jefferson Medical College; Surgeon to the Hospital of the Jefferson Medical College; Consulting Surgeon to the Philadelphia General Hospital, Saint Joseph's Hospital and Misericordia Hospital.

1917. Darrach, William, A.B., M.A., M.D., 437 West Fifty-ninth Street, New York City. Associate Professor of Surgery and Dean of the Medical Faculty, College of Physicians and

ELECTED

Surgeons, Columbia University; Consulting Surgeon, Memorial Hospital, Morristown, N. J.

1916. Davis, Carl B., A.B., M.D., 122 South Michigan Boulevard, Chicago, Ill. Assistant Professor of Surgery, Rush Medical College; Associate Surgeon, Presbyterian Hospital, Chicago.

1917. Davis, John Staige, Ph.B., M.D., F.A.C.S., Severn Apartments, Baltimore, Md. Instructor in Clinical Surgery, Johns Hopkins University; Visiting and Plastic Surgeon, Union Protestant Infirmary, Hospital for the Women of Maryland, Children's Hospital School; Assistant Visiting Surgeon and Dispensary Surgeon, Johns Hopkins Hospital.

1919. Davis, Lincoln, A.B., M.D., 217 Beacon Street, Boston, Mass. Associate in Surgery, Harvard Graduate School of Medicine; Visiting Surgeon, Massachusetts General Hospital; Consulting Surgeon, Massachusetts Charitable Eye and Ear Infirmary, Heywood Memorial Hospital, Gardner, Milford Hospital, Milford.

1923. David, Vernon C., A.B., M.D., 25 East Washington Street, (Room 1927), Chicago, Ill. Assistant Professor of Surgery, Rush Medical College; Associate Attending Staff, Surgery, Presbyterian Hospital; Attending Staff, Surgery, Cook County Hospital; Senior Attending Staff, Surgery, Evanston Hospital.

1912. Deaver, Harry C., M.D., 1701 Spruce Street, Philadelphia. Professor of Surgery, Woman's Medical College of Pennsylvania; Surgeon-in-Chief to Kensington Hospital for Women; Surgeon to the Episcopal Hospital and to the Children's Hospital of the Mary Drexel Home.

1892. Deaver, John B., M.D., Sc.D., LL.D., 1634 Walnut Street, Philadelphia. Emeritus John Rhea Barton Professor of Surgery, University of Pennsylvania, Philadelphia; Surgeon-in-Chief to the Lankenau Hospital, Philadelphia.

1910. Delatour, H. Beeckman, M.D., 73 Eighth Avenue, Brooklyn, N. Y. Attending Surgeon, St. John's and Norwegian Hospitals; Consulting Surgeon, Kingston Avenue Hospital, Brooklyn, St. Mary's Hospital, Jamaica, and Northport Hospital.

†1882. Dennis, Frederic Shepard, M.D., F.R.C.S. (Eng.), 62 East Fifty-fifth Street, New York. Professor Emeritus of Clinical Surgery, Cornell University, New York City; Consulting Surgeon to the Bellevue and Attending Surgeon to St. Vincent's Hospitals; Consulting Surgeon to St. Joseph's

ELECTED

Hospital, Yonkers, and Montefiore Home, New York City, Litchfield County Hospital, Winsted, Conn. *President*, 1894; *Vice-President*, 1887; *Member of Council*, 1889.

1910. Dowd, Charles N., A.M., M.D., 138 West Fifty-eighth Street, New York, N. Y. Professor of Clinical Surgery, Columbia University; Attending Surgeon, Roosevelt Hospital; Consulting Surgeon, Memorial Hospital, St. Mary's Free Hospital for Children, New York, Richmond Memorial Hospital, and Lulu Thorley Home for Crippled Children. *Member of Council*, 1918.

1914. Downes, William A., M.D., 424 Park Avenue, New York, N. Y. Assistant Professor of Clinical Surgery, Columbia University, College of Physicians and Surgeons; Attending Surgeon, St. Luke's, Memorial and Babies' Hospitals; Consulting Surgeon, Manhattan State Hospital, Hospital for Ruptured and Crippled, Infirmary for Women and Children, New York, United Hospital, Portchester, N. Y.

1919. Eastman, Joseph Rilus, A.M., B.Sc., M.D., F.A.C.S., 331 North Delaware Street, Indianapolis, Ind. Professor of Surgery, Indiana University School of Medicine; Visiting Surgeon to City Hospital.

1901. Eliot, Ellsworth, Jr., M.D., 34 East Sixty-seventh Street, New York. Surgeon to the Presbyterian Hospital. *Vice-President*, 1922.

†1893. Elliot, John Wheelock, A.M., M.D. (Harvard), 124 Beacon Street, Boston. Surgeon to Massachusetts General Hospital, 1893–1907; Clinical Instructor in Gynecology, 1888–9, and Lecturer on Surgery, 1900–5, Harvard Medical School; Chairman, N. E. Surgical Dressings Committee, 1917.

1911. Elting, Arthur W., A.B., M.D., LL.D., 119 Washington Avenue, Albany, N. Y. Professor of Surgery in the Albany Medical College; Surgeon to the Albany Hospital, and Surgeon to the Child's Hospital, Albany, N. Y.

†1896. Estes, William Lawrence, A.M., M.D., South Bethlehem, Pa. Director and Surgeon-in-Chief of St. Luke's Hospital, Lecturer on Hygiene at Lehigh University.

†1898. Eve, Duncan, A.M., M.D., Eve Building, Nashville, Tenn. Professor of Surgery and Clinical Surgery, Medical Department, Vanderbilt University; Chief Surgeon of the N. C. & St. Louis Railway; Consulting Surgeon to Nashville City, St. Thomas and Woman's Hospitals.

ELECTED

1899. FINNEY, JOHN M. T., M.D., 1300 Eutaw Place, Baltimore, Md. Professor of Clinical Surgery, Johns Hopkins University. *President*, 1921.

1921. FISHER, WILLIAM A., JR., M.D., 715 Park Avenue, Baltimore, Md. Associate in Clinical Surgery, Johns Hopkins University; Assistant Visiting Surgeon, Johns Hopkins Hospital; Visiting Surgeon, Union Memorial Hospital, Church Home and Infirmary, Hospital for the Women of Maryland, Children's Hospital School.

1904. FRAZIER, CHARLES HARRISON, M.D., 1724 Spruce Street, Philadelphia, Pa. John Rhea Barton Professor of Surgery, University of Pennsylvania; Surgeon-in-Chief to the University Hospital.

†1898. FREEMAN, LEONARD, B.S., M.D., 424 Metropolitan Building, Denver, Col. Professor of Surgery, Medical Department, University of Colorado; Surgeon to Denver City and County, St. Joseph's, and National Jewish Hospitals; Consulting Surgeon, Children's and Mercy Hospitals, Denver, Col. *Vice-President*, 1908.

1910. GAGE, HOMER, A.M., M.D., *Vice-President*, 72 Pearl Street, Worcester, Mass. Surgeon-in-Chief to Memorial Hospital; Consulting Surgeon to Worcester City and St. Vincent's Hospitals.

1922. GALLIE, WILLIAM E., M.D., F.A.C.S., F.R.C.S. (ENG.), 143 College Street, Toronto, Canada. Associate Professor of Surgery, University of Toronto; Surgeon-in-Chief, Hospital for Sick Children, Toronto.

1919. GAUB, OTTO CARL, M.D., F.A.C.S. Hotel Schenley, Pittsburgh, Pa. Surgeon to Allegheny General Hospital and to Columbia Hospital.

†1882. GAY, GEORGE WASHINGTON, A.M., M.D., 665 Boylston Street, Boston, Mass. Senior Surgeon to the Boston City Hospital. *Member of Council*, 1882.

1906. GIBBON, JOHN H., M.D., 1608 Spruce Street, Philadelphia. Professor of Surgery, Jefferson Medical College and Surgeon to the Jefferson College Hospital; Surgeon to the Pennsylvania Hospital and Consulting Surgeon to the Bryn Mawr Hospital. *Secretary*, 1915–1922.

1906. GIBSON, C. L., M.D., 72 East Fifty-fourth Street, New York, N. Y. Professor of Surgery, Cornell University Medical College; Attending Surgeon to the First Surgical (Cornell Medical) Division of the New York Hospital; Consulting

ELECTED

Surgeon to St. Luke's, City, and General Memorial Hospitals. *Vice-President*, 1915.

1920. GRAHAM, EVARTS A., A.B., M.D., Euclid Avenue and Kingshighway, St. Louis, Mo. Professor of Surgery, Washington University Medical School, St. Louis, Missouri; Surgeon-in-Chief to Barnes Hospital and St. Louis Children's Hospital; Consulting Surgeon, City Hospital No. 20.

1911. GREENOUGH, ROBERT B., A.B. (Harvard), M.D. (Harvard), *Secretary*, 8 Marlborough Street, Boston, Mass. Assistant Professor of Surgery, Harvard Medical School; Visiting Surgeon, Massachusetts General Hospital.

1922. GUERRY, LE GRAND, M.D., F.A.C.S., Columbia, S. C. Surgeon to Columbia Hospital, Columbia, S. C.

1916. HAGGARD, WILLIAM D., M.D., F.A.C.S., 706 Church Street, Nashville, Tenn. Professor of Surgery, Vanderbilt University; Surgeon to St. Thomas' Hospital.

1909. HALSTEAD, ALBERT E., M.D., 30 N. Michigan Avenue, Chicago, Ill. Professor of Surgery, School of Medicine, University of Illinois; Attending Surgeon to the St. Luke's and Cook County Hospitals; Consulting Surgeon to the Illinois Charitable Eye and Ear Infirmary; Lieut.-Col., M.C., U.S.A.

1909. HAMANN, CARL A., M.D., 416 Osborn Building., Cleveland, Ohio. Professor of Applied Anatomy, Western Reserve University; Visiting Surgeon to Charity and City Hospitals.

1900. HARRIS, MALCOLM L., M.D., 25 E. Washington Street, Chicago, Ill. Professor of Surgery, Chicago Policlinic; Attending Surgeon, Alexian Brothers' Hospital, Henrotin Hospital, Passavant Hospital; Consulting Surgeon to Maurice Porter Hospital for Children.

†1895. HARTE, RICHARD H., M.D., C.M.G., 1503 Spruce Street, Philadelphia. Emeritus Surgeon to the Pennsylvania Hospital and Consulting Surgeon to St. Mary's, St. Timothy's, Abington, and Bryn Mawr Hospitals; Colonel M.R.C., U.S.A; formerly Director Base Hospital No. 10, U.S.A., and later O. C. No. 16, General Hospital, B.E.F. *President*, 1910.

1916. HARTWELL, JOHN A., PH.B., M.D., 27 East Sixty-third Street, New York. Associate Professor of Surgery and Professor of Clinical Surgery, Cornell University Medical College; Director of Surgery, Cornell University Division, Bellevue Hospital; Consulting Surgeon to Lincoln Hospital, Lawrence

ELECTED

Hospital, Bronxville, N. Y., and United Hospital, Portchester, N. Y.

1922. Heuer, George J., M.D., Cincinnati General Hospital, Cincinnati, Ohio. Professor of Surgery, University of Cincinnati College of Medicine; Surgical Director of the Cincinnati General Hospital.

1922. Hitzrot, James Morley, A.B., M.D., 126 East Thirty-seventh Street, New York City. Professor of Clinical Surgery, Cornell Medical School; Associate Surgeon, New York Hospital.

1918. Hodge, Edward Blanchard, A.B., M.D., 2019 Spruce Street, Philadelphia, Pa. Surgeon to Presbyterian and Children's Hospitals; Out-patient Surgeon to Pennsylvania Hospital; Associate Surgeon to Widener Memorial School.

1923. Homans, John, A.M., M.D., Peter Bent Brigham Hospital, 721 Huntington Avenue, Boston, Mass. Instructor in Surgery, Harvard Medical School; Surgeon to the Peter Bent Brigham Hospital.

1909. Hotchkiss, Lucius Wales, A.B., M.D., San Marcos Building, Santa Barbara, Calif. Professor of Clinical Surgery, Columbia University; Consulting Surgeon to Bellevue, Knickerbocker, Flushing and Greenwich Hospitals; Junior Surgeon to Roosevelt Hospital, New York City.

1918. Hubbard, Joshua C., M.D., 86 Bay State Road, Boston, Mass. Visiting Surgeon, Boston City Hospital; Surgeon, Newton Hospital; Consulting Surgeon, Norwood Hospital and Leonard Morse Hospital.

†1901. Huntington, Thomas W., A.B., M.D., LL.D., 960 Mills Building, San Francisco, California. Professor of Clinical and Operative Surgery (Emeritus), College of Medicine, University of California; Consulting Surgeon, St. Luke's Hospital, San Francisco; Chief Surgeon, Western Pacific R. R. *Vice-President*, 1906; *President*, 1917; *Member of Council*, 1918–20.

1919. Hupp, Frank Le Moyne, A.M., M.D., 61 Fourteenth Street. Wheeling, W. Va. Attending Surgeon, Ohio Valley General Hospital; Consulting Surgeon, Reynolds Memorial Hospital, Glendale; Sheltering Arms Hospital, Hansford.

1913. Hutchison, James Alexander, M.D., L.R.C.P. and S. (Edin.), 354 MacKay Street, Montreal. Professor of Surgery and Clinical Surgery, McGill University; Attending Surgeon, Montreal General Hospital.

ELECTED

†1909. HUTCHINSON, JAMES P., M.D., 133 South Twenty-second Street, Philadelphia. Surgeon to the Pennsylvania, Methodist, Children's, St. Timothy's and Bryn Mawr Hospitals.

1913. JACKSON, JABEZ N., A.M., M.D., 425 Argyle Building, Kansas City, Mo. Surgeon and Chief of Staff of Christian Church Hospital; Surgeon, Kansas City General Hospital.

†1905. JOHNSON, ROBERT W., A.B., M.D., 101 W. Franklin Street, Baltimore, Md. Professor of Principles and Practice of Surgery, Baltimore Medical College; Surgeon to Maryland General Hospital, Church Home and Infirmary, and St. Agnes' Hospital. Retired.

†1901. JONAS, A. F., M.D., 512 McCayne Building, Omaha, Neb. Professor of Surgery, Omaha Medical College; Surgeon to the Methodist Episcopal Hospital and to the Douglas County Hospital; Captain, M.C. *Vice-President*, 1906.

1917. JONES, DANIEL FISKE, A.B., M.D., 195 Beacon Street, Boston. Mass. Visiting Surgeon, Massachusetts General Hospital; Consulting Surgeon to the New England Hospital for Women and Children, Brockton City Hospital, Union Hospital of Fall River, Sturdy Hospital of Attleboro and the Addison Gilbert Hospital of Gloucester, Mass.

1910. JOPSON, JOHN HOWARD, M.D., *Recorder*, 1824 Pine Street, Philadelphia, Pa. Professor of Surgery, the Graduate School of Medicine, University of Pennsylvania; Surgeon to Presbyterian Hospital and Children's Hospital; Consulting Surgeon to Bryn Mawr Hospital and Philadelphia Home for Incurables.

1914. JUDD, EDWARD STARR, M.D., Rochester, Minn., Surgeon to Mayo Clinic.

†1899. KAMMERER, FREDERIC, M.D., 51 East Sixty-sixth Street, New York City. Professor of Clinical Surgery, Columbia University; Attending Surgeon to the Lenox Hill Hospital; Consulting Surgeon to St. Francis Hospital, New York.

1913. KANAVEL, ALLEN B., A.B., M.D., 30 North Michigan Avenue, Chicago, Ill. Professor of Surgery, Northwestern University Medical School; Attending Surgeon to Wesley Memorial and Cook County Hospitals.

ELECTED

*†1880. KEEN, WILLIAM WILLIAMS, A.M., M.D., LL.D., Hon. F.R.C.S. (Eng., Edin. and Ireland), Hon. Ph.D. (Upsala), Hon. Sc.D. (Jeff. and Harv.), Hon. F.A.C.S., The Touraine, 1520 Spruce Street, Philadelphia. Emeritus Professor of Surgery in the Jefferson Medical College; Consulting Surgeon to the Jefferson Medical College Hospital and to the Woman's and St. Agnes' Hospitals; Membre Correspondant Etranger de la Société de Chirurgie de Paris; Membre Honoraire de la Société Belge de Chirurgie; Honorary Member, Clinical Society of London, etc. *President*, 1898; *Vice-President*, 1892; *Member of Council*, 1899–1901.

1923. KELLER, WILLIAM L., M.D., Walter Reed General Hospital, Washington, D. C. Colonel, M. C., U. S. A.; Professor of Military Surgery, Army Medical School, Army Medical Center, Washington, D. C.; Professor of Military Surgery, George Washington University; Chief of the Surgical Service, Walter Reed General Hospital.

1916. LAW, ARTHUR AYER, M.D., F.A.C.S., 420 Syndicate Building, Minneapolis, Minn. Associate Professor of Surgery, University of Minnesota Medical School, and Mayo Foundation; Surgeon to the Northwestern Hospital; Surgeon to and Assistant Chief of the University Hospital; Lieut.-Col., M.C. (discharged), Commanding University of Minnesota Base Hospital No. 26 in A.E.F.

†1901. LE CONTE, ROBERT G., A.B., M.D., 2000 Spruce Street, Philadelphia. Surgeon to the Pennsylvania Hospital; Consulting Surgeon to the Germantown, the Bryn Mawr and the Gynecean Hospitals. *President*, 1915; *Member of Council*, 1916–18.

1919. LEE, BURTON JAMES, PH.B., M.D., F.R.C.S., 128 East Seventy-third Street, New York. Clinical Professor of Surgery, Cornell Medical School; Associate Attending Surgeon, New York Hospital; Consulting Surgeon, Sharon (Connecticut) Hospital.

1923. LEE, WALTER ESTELL, M.D., F.A.C.S., 905 Pine Street, Philadelphia, Pa. Associate Professor of Surgery, Graduate School of Medicine, University of Pennsylvania; Surgeon to the Pennsylvania, Germantown, Bryn Mawr and Children's Hospitals and the Associated Medical Clinics; Consulting Surgeon to the Henry Phipps Institute for Tuberculosis and the Medical Department of the State of Pennsylvania.

ELECTED

1912. Lewis, Dean D., M.D., 122 S. Michigan Ave., Chicago, Ill. Professor of Surgery, Rush Medical College; Attending Surgeon to the Presbyterian Hospital, Chicago; Consulting Surgeon to the Annie Durand Hospital for Contagious Diseases.

1910. Lilienthal, Howard, A.B., M.D., 52 East Eighty-second Street, New York. Attending Surgeon, Mount Sinai Hospital; Visiting Surgeon to Bellevue Hospital; Consulting Surgeon, Hospital for Joint Diseases, Jewish Maternity Hospital and Har Moriah Hospital; Professor of Clinical Surgery, Cornell Medical College; formerly Lieut.-Col., M.C., U.S.A.

1908. Lothrop, Howard Augustus, A.M., M.D., 101 Beacon Street, Boston, Mass. Assistant Professor of Surgery, Harvard Medical School; Surgeon-in-Chief, Boston City Hospital.

1916. Lower, William E., M.D., Euclid Avenue and Ninety-third Street, Cleveland, Ohio. Associate Professor of Genito-urinary Surgery, School of Medicine, Western Reserve University; Director of Surgery, Mount Sinai Hospital; Associate Surgeon in charge of Genito-urinary Surgery, Lakeside Hospital; Visiting Surgeon, Lutheran Hospital and White Hospital (Ravenna).

1910. Lund, Frederick Bates, M.D., 527 Beacon Street, Boston, Mass. Associate in Surgery, Harvard Medical School; Surgeon-in-Chief, Boston City Hospital; Consulting Surgeon, Burbank Hospital, Fitchberg, Newton Hospital, Newton; lately Lieut.-Col., M.C., U.S.A.

1917. Lyle, Henry H. M., M.D., 117 East Fifty-sixth Street, New York City. Professor of Clinical Surgery, College of Physicians and Surgeons, Columbia University; Attending Surgeon, St. Luke's Hospital.

1901. McArthur, L. L., M.D., 122 S. Michigan Boulevard, Chicago, Ill. Professor of Clinical Surgery, Post-Graduate Medical School; Assistant Professor of Clinical Surgery, Rush Medical College; Senior Surgeon to St. Luke's and Michael Reese Hospitals. *President*, 1922.

1923. McGuire, Edgar R., M.D., F.A.C.S., 622 Delaware Avenue, Buffalo, N. Y. Professor of Surgery, University of Buffalo; Surgeon, Buffalo General Hospital; Surgeon-in-Chief, Buffalo City Hospital.

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1917. McGuire, Stuart, M.D., LL.D., 513 East Grace Street, Richmond, Va. Professor of Surgery, Medical College of Virginia; Surgeon in Charge of St. Luke's Hospital; Visiting Surgeon to Memorial Hospital.

‡1903. McMurtry, Lewis S., A.M., M.D., LL.D., 542 Atherton Building, Louisville, Ky. Professor of Gynecology and Abdominal Surgery in the Medical Department, University of Louisville; Surgeon to the Louisville City Hospital.

1918. McWilliams, Clarence A., M.A., M.D., 19 East Sixty-fifth Street, New York, N. Y. Associate Surgeon, Fifth Avenue and New York Polyclinic Hospitals; Attending Surgeon, New York Skin and Cancer Hospital.

1904. MacLaren, Archibald, M.D., B.S., 914 Lowry Building, St. Paul, Minn. Professor of Clinical Surgery, University of Minnesota. *Vice-President*, 1915. *Recorder*, 1910–1914.

1914. MacLaren, Murray, B.A., M.B.C.M., M.D., M.R.C.S. (Eng.), C.M.G. (Order of Avis), LL.D., 75 Coburg Street, St. John's, N.B., Canada. Surgeon to the General Public Hospital; Colonel, C.A.M.C.

1920. Maes, Urban, M.D., 1671 Octavia Street, New Orleans, Louisiana. Professor of Clinical and Operative Surgery, Tulane University of Louisiana School of Medicine; Junior Surgeon, Charity Hospital, Touro Infirmary; Senior Surgeon, New Orleans Dispensary for Women and Children.

†1898. Martin, Edward, A.M., M.D., LL.D., 135 S. Eighteenth Street, Philadelphia. Professor of Surgical Physiology, University of Pennsylvania; Consulting Surgeon to State Hospitals, Norristown and Wernersville, Pa.; Colonel, M.R.C., U. S. A.

1915. Martin, Walton, Ph.B., M.D., 151 East Sixty-third Street, New York. Professor of Clinical Surgery, Columbia University; Attending Surgeon, St. Luke's Hospital; Consulting Surgeon, White Plains Hospital and Loomis Sanatorium.

†1895. Mastin, William McDowell, M.D., LL.D., Northeast corner of Joachim and Conti Streets, Mobile, Ala. Surgeon to the Mobile City Hospital and Providence Infirmary.

1895. Matas, Rudolph, M.D., LL.D., 2255 St. Charles Avenue, New Orleans, Louisiana. Professor of Surgery, Tulane University of Louisiana, School of Medicine; Professor (Emeritus), Graduate Medical School, Tulane University; Senior, Surgical Division, Touro Infirmary; Chief of Surgical Service, Visiting Staff, Charity Hospital; Consulting Surgeon, Eye, Ear, Nose and Throat Hospital; Major,

ELECTED

Reserve Corps, U. S. Army. *President*, 1909; *Vice-President*, 1901.

1918. Mathews, Francis Stuart, B.S., M.D., F.A.C.S., 62 West Fiftieth Street, New York. Professor of Clinical Surgery, Columbia University; Surgeon to St. Luke's Hospital and St. Mary's Hospital for Children.

1903. Mayo, Charles H., A.M., M.D., LL.D., D.Sc., F.A.C.S., Rochester, Minn. Professor of Surgery, Medical School, University of Minnesota; Surgeon to Mayo Clinic (St. Mary's Hospital).

1899. Mayo, William J., A.M., M.D. (Mich.), D.Sc. (Columbia and Mich.), F.R.C.S. (Eng. and Edin.), LL.D. (Tor., Md. and Penna.), Cor. Etr., Soc. de Chir. de Paris, F.A.C.S., 701 College Hill, Rochester Minn. Surgeon to St. Mary's Hospital. *Vice-President*, 1903; *President*, 1915.

†1901. Meyer, Willy, M.D., 700 Madison Avenue, New York. Professor of Surgery in the New York Post-Graduate Medical School and Hospital; Attending Surgeon to the Lenox Hill Hospital; Consulting Surgeon to the New York Infirmary for Women and Children, New York Skin and Cancer Hospital, Hospital for Deformities and Joint Diseases and the Montefiore Hospital.

1919. Miller, Robert Talbott, A.B., M.D., Johns Hopkins Hospital, Baltimore, Md.

1917. Mitchell, Charles F., M.D., 332 South Fifteenth Street, Philadelphia, Pa. Attending Surgeon to the Germantown, Bryn Mawr and Pennsylvania Hospitals.

1912. Mitchell, James F., A.B., M.D., 1344 Nineteenth Street, Washington, D. C. Clinical Professor of Surgery, Georgetown and George Washington Universities; Chief Surgeon, Emergency Hospital. *Vice-President*, 1920.

†1893. Mixter, Samuel Jason, S.B. (Massachusetts Institute of Technology), M.D. (Harvard), 180 Marlborough Street, Boston. Consulting Surgeon to Massachusetts General Hospital and to Massachusetts Charity Eye and Ear Infirmary. *President*, 1916; *Member of Council*, 1917–19.

1920. Mixter, William Jason, S.B., M.D., F.A.C.S., 180 Marlborough Street, Boston, Massachusetts. Assistant Visiting Surgeon, Massachusetts General Hospital; Assistant in Surgery, Graduate School of Medicine, Harvard University; Surgeon to the Staff, Anna Jaques Hospital, Newburyport; Consulting Surgeon, Leonard Morse Hospital, Natick,

ELECTED

Charitable Eye and Ear Infirmary, Boston, Cable Memorial Hospital, Ipswich; Ex. Lieut.-Col., M.C., U.S.A.

†1896. Monks, George Howard, A.B. (Harvard), M.D. (Harvard), M.R.C.S. (Eng.), 51 Commonwealth Avenue, Boston. Consulting Surgeon, Boston City Hospital; Professor of Oral Surgery, Harvard Dental School.

1914. Moschcowitz, Alexis V., M.D., 925 Madison Avenue, New York, N. Y. Professor of Clinical Surgery, College of Physicians and Surgeons, Columbia University; Attending Surgeon, Mount Sinai Hospital.

1904. Mudd, Harvey G., M.D., Humboldt Building, St. Louis, Mo. Clinical Professor of Surgery, Medical Department, Washington University; Surgeon to St. Luke's Hospital; Consulting Surgeon to the Barnard Free Skin and Cancer Hospital. *Vice-President*, 1920.

1919. Müller, George P., M.D., 1930 Spruce Street, Philadelphia, Pa. Professor of Surgery, Graduate School of the University of Pennsylvania; Professor of Clinical Surgery, Medical School of the University of Pennsylvania; Surgeon to the Misericordia and St. Agnes Hospitals; Consulting Surgeon to the Chester County Hospital, West Chester, Pa.

1913. Murphy, Fred T., A.B., M.A., M.D., 2248 Penobscot Building, Detroit, Michigan.

†1898. Murray, Francis W., M.D., 32 West Thirty-ninth Street, New York City. Consulting Surgeon, New York Hospital, St. Luke's Hospital, New York Eye and Ear Infirmary, Paul Kimball Hospital, Lakewood, Goshen Emergency Hospital.

1903. Neilson, Thomas R., M.D., 1937 Chestnut Street, Philadelphia, Pa. Surgeon to the Episcopal Hospital and to St. Christopher's Hospital for Children; Clinical Professor of Genito-urinary Diseases in the University of Pennsylvania.

†1900. Ochsner, A.J., B.S., F.R.M.S., M.D. (Eng.), LL.D.; F.A.C.S., 710 Sedgwick Street, Chicago. Professor of Clinical Surgery, College of Physicians and Surgeons; Surgeon-in Chief of Augustana and St. Mary's Hospitals.

1900. Oliver, J. C., M.D., 628 Elm Street, Cincinnati, Ohio. Acting Dean and Professor of Surgery, Medical Department, University of Cincinnati; Director of Second Surgical Service, Cincinnati General Hospital; Surgeon to the Christ Hospital.

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1915. Olmsted, Ingersoll, M.B., 215 James Street, South, Hamilton, Ontario. Surgeon to City Hospital.

1923. Palmer, Dudley White, B.S., M.D., F.A.C.S., 707 Race Street, Pearl Market Bank Building, Cincinnati, Ohio. Associate Professor of Clinical Surgery, University of Cincinnati, Medical Department; Attending Surgeon, Cincinnati General Hospital and Christ Hospital; Consulting Surgeon, Cincinnati Tuberculosis Sanitarium.

1899. Parham, Frederick William, M.D., 3513 Prytania Street, New Orleans, La. Professor of General Clinical Surgery, New Orleans Polyclinic (Post-Graduate Department of Tulane University of Louisiana); Chief of Staff to Charity Hospital and to Touro Infirmary.

†1893. Parmenter, John, M.D., 519 Franklin Street, Buffalo, N. Y. Late Professor of Clinical Surgery, Medical Department, University of Buffalo.

1908. Peck, Charles Howard, M.D., *Treasurer*, 30 W. Fiftieth Street, New York City. Professor of Clinical Surgery, Columbia University; Senior Attending Surgeon to the Roosevelt Hospital; Consulting Surgeon to French Hospital, Memorial Hospital and Hospital for Ruptured and Crippled, New York City; Vassar Brothers Hospital, Poughkeepsie, N. Y.; Nyack Hospital, Nyack N. Y.; White Plains Hospital, White Plains, N. Y.; United Hospital, Portchester and Rye, N. Y.; Stamford Hospital, Stamford, Conn.; Greenwich Hospital, Greenwich, Conn.; Hackensack Hospital, Hackensack, N. J.

1919. Percy, Nelson Mortimer, M.D., F.A.C.S., 2106 Sedgwick Street, Chicago, Ill. Associate Professor of Clinical Surgery, Medical Department of the University of Illinois; Attending Surgeon to the Augustana and St. Mary's of Nazareth Hospitals.

1917. Phemister, Dallas B., B.S., M.D., 122 South Michigan Avenue, Chicago, Ill. Assistant Professor in Surgery, Rush Medical College; Associate Attending Surgeon, Presbyterian Hospital.

†1889. Pilcher, Lewis Stephen, A.M., M.D., LL.D. (Dickinson and University of Michigan), 145 Gates Avenue, Brooklyn, N. Y. Consulting Surgeon to the St. John, Norwegian, Jewish, Bushwick and Deaconess Hospitals. *Vice-President*, 1893, 1914. *President*, 1918. *Member of Council*, 1919–21.

ELECTED

1914. Plummer, Samuel C., A.B., M.D., 4539 Oakenwald Avenue, Chicago, Ill. Attending Surgeon, St. Luke's Hospital; Chief Surgeon, C. R. I. & P. Ry. Co.

1914. Pool, Eugene Hillhouse, A.B., M.D., 107 East Sixtieth Street, New York, N. Y. Attending Surgeon, New York Hospital; Associate Professor of Surgery, Columbia University; Consultant Surgeon to French Hospital, New York Orthopedic, Manhattan State Hospital, Home for Incurables and United Hospital at Portchester.

1904. Porter, Charles Allen, A.M., M.D., 116 Beacon Street, Boston, Mass. Chief of West Surgical Service, Massachusetts General Hospital; Professor of Clinical Surgery, Harvard Medical School.

1915. Porter, Miles Fuller, M.A., M.D., Walnut Place, Fort Wayne, Ind. Professor of Surgery in the Indiana University School of Medicine; Surgeon to St. Joseph's Hospital; Consulting Surgeon in the Indiana School for Feeble-minded Youths.

1908. Primrose, Alexander, C.B., M.B., C.M. (Edin.), M.R.C.S. (Eng.), 100 College Street, Toronto, Canada. Surgeon to the Toronto General Hospital and Consulting Surgeon to the Hospital for Sick Children, Toronto; Professor of Clinical Surgery in the University of Toronto. *Vice-President*, 1922.

1923. Richardson, Edward P., A.B., M.D., Massachusetts General Hospital, Boston, Mass. Assistant Professor of Surgery, Harvard Medical School; Chief of Third Surgical Service, Massachusetts General Hospital.

1901. Rixford, Emmet, B.S., M.D., 1795 California Street, San Francisco, Cal. Professor of Surgery in Stanford University School of Medicine; Surgeon to the San Francisco and Lane Hospitals; Member of the Society of Clinical Surgery. *Vice-President*, 1905.

†1882. Roberts, John B., A.M., M.D., 313 South Seventeenth Street, Philadelphia. Professor of Surgery in the University of Pennsylvania Graduate School of Medicine. *Vice-President*, 1888 and 1894; *Treasurer*, 1892–93; *President*, 1920.

1917. Rowan, Charles J., A.B., M.D., Iowa City, Iowa. Professor and Head of Department of Surgery, College of Medicine, State University of Iowa; Director of the University Hospital.

ELECTED

1922. Royster, Hubert A., A.B., M.D., Raleigh, N. C. Surgeon to Rex Hospital; Surgeon-in-Chief to St. Agnes Hospital; Consulting Surgeon to Dix Hill State Hospital for the Insane.

†1882. Rushmore, John Dikeman, M.D., 129 Montague Street, Brooklyn, N. Y. Professor of Operative and Clinical Surgery, Emeritus, Long Island College Hospital; Surgeon to St. Peter's Hospital; Consulting Surgeon to Long Island College Hospital, Kings County Hospital, Swedish and Lutheran Hospitals.

†1909. Scudder, Charles L., M.D., A.B., Ph.B., 209 Beacon Street, Boston, Mass. Assistant Professor of Surgery, Harvard Medical School; Chief of the East Surgical Service, Massachusetts General Hospital; Member of the Administrative Board of the Graduate School of Medicine, Harvard University.

1919. Seelig, M. G., A.B., M.D., 4952 Park View Place, St. Louis, Mo. Professor of Surgery, St. Louis University; Visiting Surgeon to the Jewish Hospital and to the St. Louis City Hospital.

†1902. Shepherd, Francis J., M.D., LL.D., F.R.C.S. (Eng.), 152 Mansfield Street, Montreal, Canada. Emeritus Professor in McGill University; Consulting Surgeon to the Montreal General Hospital and Royal Victoria Hospital, Montreal.

1923. Shipley, Arthur M., M.D., Sc.D., 1827 Eutaw Place, Baltimore, Md. Professor of Surgery and Head of the Department of Surgery, University of Maryland; Chief Surgeon, University Hospital, City Hospitals and Sydenham Hospital; Visiting Surgeon, Union Memorial Hospital, Hospital for Women of Maryland, Mercy Hospital and Maryland General Hospital.

1920. Sistrunk, Walter E., M.D., F.A.C.S., Surgeon to Saint Mary's and the Colonial Hospitals (Mayo Clinic), Rochester, Minn.; Associate Professor of Surgery, Mayo Foundation. University of Minnesota.

1918. Smith, Rea, M.D., The Medical Office Building, 1136 West Sixth Street, Los Angeles, Cal. Surgeon, California Hospital and Los Angeles County Hospital.

†1895. Souchon, Edmond, M.D., 2403 St. Charles Avenue, New Orleans, La. Professor of Anatomy and of Clinical Surgery, Tulane University; Surgeon to Charity Hospital; Consult-

ELECTED

ing Surgeon to the Eye, Ear, Nose, and Throat Hospital. Honorary Fellow of American College of Surgeons; Former President of Louisiana State Board of Health, 1898–1905. *Vice-President*, 1899.

1919. Speed, Kellogg, S.B., M.D., F.A.C.S., 122 South Michigan Avenue, Chicago, Ill. Assistant Professor of Surgery, Rush Medical College, Attending Surgeon, Cook County and Provident Hospitals; Assistant Surgeon, Presbyterian Hospital; Consulting Surgeon, U. S. P. H. S. Hospital No. 2.

1922. Speese, John, M.D., 2032 Locust Street, Philadelphia, Pa. Associate Professor of Surgery, Graduate School, University of Pennsylvania; Surgeon to the Presbyterian Hospital, Children's Hospital, and the Philadelphia Home for Incurables.

1918. Starr, Clarence Leslie, M.B., M.D., 224 Bloor Street, West, Toronto, Canada. Professor of Surgery, University of Toronto; Surgeon-in-Chief, Toronto General Hospital; Consultant in Surgery, Hospital for Sick Children; Surgeon to St. John's Hospital; Lieut.-Col.-Consultant, C. A. M. C.

1914. Starr, Frederic Newton Gisborne, C.B.E., M.B., M.D., C.M., 112 College Street, Toronto, Canada. Associate Professor of Clinical Surgery, University of Toronto; Surgeon to Hospital for Sick Children, and to St. John's Hospital for Women; Senior Assistant Surgeon, Toronto General Hospital.

1915. Stewart, George David, M.D., 61 West Fiftieth Street, New York. President, New York Academy of Medicine; Professor of Surgery, New York University Medical School; Visiting Surgeon to St. Vincent's and Bellevue Hospitals; Consulting Surgeon to Hospital for Ruptured and Crippled of New York, to St. Joseph's Hospital, Yonkers, to St. Mary's Hospital, East Orange, N. J., to South Side Hospital, Babylon, L. I., to Englewood Hospital, Englewood, N. J., and to the United Hospital, Portchester, N. Y.

1909. Stillman, Stanley, M.D., 2101 Webster Street, San Francisco, Cal. Professor of Surgery, Stanford University Medical School; Commander, M. C., U. S. N. R. F.; Surgeon to Lane and Stanford University Hospitals.

1923. St. John, Fordyce Barker, B.S., M.D., Presbyterian Hospital, 41 East Seventieth Street, New York City. Associate Professor of Surgery, College of Physicians and Surgeons; Visiting Surgeon to the Presbyterian Hospital.

ELECTED

1909. Summers, John Edward, M.D., Bankers Reserve Life Building, Nineteenth and Douglas Streets, Omaha, Neb. Professor of Clinical Surgery, University of Nebraska Medical School; Surgeon to the University Hospital and to the Clarkson Memorial, the Wise Memorial, and the Douglas County Hospitals, Omaha, Neb.

1920. Taylor, Alfred S., B.P., A.M., M.D., 115 W. Fifty-fifth Street, New York. Professor of Clinical Surgery, Cornell Medical School; Visiting Surgeon, Fordham Hospital and Neurological Institute; Neurological Surgeon, Hospital for Ruptured and Crippled; Consulting Surgeon to Memorial Hospital, New York City, Tarrytown Hospital, New York, White Plains Hospital, New York, Overlook Hospital, Summit, N. J.

†1900. Taylor, William J., M.D., 1825 Pine Street, Philadelphia. Surgeon to the Orthopædic Hospital and Infirmary for Nervous Diseases, and to St. Agnes' Hospital; Consulting Surgeon to the West Philadelphia Hospital for Women and to the Woman's Hospital.

1916. Terry, Wallace I., B.S., M.D., 240 Stockton Street, San Francisco, Cal. Professor of Surgery, University of California; Chief Surgeon, University of California Hospital, San Francisco.

1909. Thompson, James E., M.B., B.S. (London), F.R.C.S. (Eng.), F.A.C.S., 3224 Broadway, Galveston, Texas. Professor of Surgery in the University of Texas; Surgeon to the John Sealy Hospital. *Vice-President*, 1922.

1920. Tinker, Martin B., B.S., M.D., 101 South Aurora Street, Ithaca, N. Y. Surgeon to the Ithaca City Hospital and the Cornell Infirmary.

1918. Truesdale, Philemon Edwards, M.D., 177 Winter Street, Fall River, Mass. Surgeon to St. Anne's and Highland Hospitals; Consulting Surgeon to Fall River City Hospital.

†1882. Vander Veer, Albert, A.M., M.D., Ph.D., LL.D., 28 Eagle Street, Albany, N. Y. Surgeon-in-Chief, Albany Hospital; Consulting Surgeon, Albany Free Dispensary Association, Benedictine Hospital, Kingston, N. Y., and Champlain Valley Hospital, Plattsburgh, N. Y. *President*, 1905; *Vice-President*, 1898; *Member of Council*, 1907.

ELECTED

1910. VANDER VEER, EDGAR ALBERT, Ph.B., M.D., 28 Eagle Street, Albany, N. Y. Attending Surgeon, Albany Hospital; Consulting Surgeon, Champlain Valley Hospital and Benedictine Hospital, Kingston, N. Y.

1902. VAUGHAN, GEORGE TULLY, M.D., LL.D., 1718 I Street, Washington, D. C. Professor of Principles and Practice of Surgery and Head of the Surgical Department, Georgetown University; Chief Surgeon, Georgetown University Hospital; Surgeon, Tuberculosis Hospital; Consulting Surgeon, Government Hospital for the Insane, Washington, D. C., U. S. Public Health Service and Washington Asylum Hospital; Commander, M. C., Reserve Force, U. S. N.

1921. VAUGHAN, J. WALTER, A.B., M.D., 987 East Jefferson Avenue, Detroit, Mich. Associate Attending Surgeon to Harper Hospital.

1920. VERDI, WILLIAM FRANCIS, A.M., M.D., 27 Elm Street, New Haven, Connecticut. Clinical Professor of Surgery, Yale University School of Medicine; Chief Surgeon, Hospital of St. Raphael; Attending Surgeon, New Haven Hospital; Consulting Surgeon, St. Vincent's Hospital, Bridgeport, St. Mary's Hospital, Waterbury, Middlesex Hospital, Middletown.

1922. VINCENT, BETH, A.B., M.D., 295 Beacon Street, Boston, Mass. Assistant Visiting Surgeon, Massachusetts General Hospital; Consulting Surgeon, Infants Hospital, Boston; Assistant in Surgery, Harvard Medical School.

1918. WAINWRIGHT, JONATHAN M., A.B., A.M., M.D., 912 Clay Avenue, Scranton, Pa. Surgeon-in-Chief, Moses Taylor Hospitals (Scranton and Buffalo); Chief Surgeon, D. L. & W. R. R. Co.

†1891. WALKER, EDWARD W., M.D., 214 West Seventh Street, Cincinnati, Ohio. Professor of Surgery, Miami Medical College.

1909. WALKER, JOHN B., M.D., 51 East Fiftieth Street, New York City. Surgeon to Bellevue Hospital and Hospital for Ruptured and Crippled, New York; Professor of Clinical Surgery, College of Physicians and Surgeons, Columbia University, N. Y.

†1882. WARREN, JOHN COLLINS, M.D., LL.D. (Jefferson, Harvard and McGill), Hon. F.R.C.S. (Eng. and Edin.), 58 Beacon Street, Boston, Mass. Emeritus Professor of Surgery in

ELECTED

Harvard University; Consulting Surgeon to the Massachusetts General Hospital. *President*, 1896; *Vice-President*, 1890; *Member of Council*, 1897.

†1896. WATSON, FRANCIS SEDGWICK, A.B., M.D., 92 Marlborough Street, Boston, Mass. Surgeon to the Boston City Hospital, Instructor in Genito-urinary Surgery, Harvard Medical School.

1913. WATTS, STEPHEN H., M.A., M.D., Department of Surgery, University of Virginia, Charlottesville, Va. Professor of Surgery and Gynecology in the University of Virginia; Surgeon-in-Chief, University of Virginia Hospital.

†1889. WEIR, ROBERT F., A.M., M.D., Hon. F.R.C.S. (Eng.), Cor. Mem. Surg. Soc., Paris, 1155 Park Avenue, New York. Professor of Surgery in the College of Physicians and Surgeons, Columbia University; Surgeon to the Roosevelt Hospital. *President*, 1899; *Member of Council*, 1893–1896; 1901–03.

†1892. WHARTON, HENRY R., A.M., M.D., 1725 Spruce Street, Philadelphia. Consulting Surgeon to the Presbyterian Hospital; Emeritus Surgeon to the Children's Hospital.

1921. WHIPPLE, ALLEN O., B.S., M.D., Presbyterian Hospital, 41 East Seventieth Street, New York, N. Y. Professor of Surgery, Columbia University; Director of Surgical Service, Presbyterian Hospital.

1921. WILLIAMS, HUGH, A.B., M.D., 301 Beacon Street, Boston, Mass. Assistant, Harvard Graduate School of Medicine; Visiting Surgeon, Massachusetts General Hospital.

1914. WINSLOW, RANDOLPH, A.B., M.D., A.M., LL.D., 1900 Mt. Royal Terrace, Baltimore, Md. Emeritus Professor of Surgery, University of Maryland.

1918. WOOD, ALFRED CONARD, M.D., 2035 Walnut Street, Philadelphia, Pa. Assistant Professor of Surgery, University of Pennsylvania; Surgeon to the University, Philadelphia General, Howard, St. Timothy's and Rush Hospitals.

†1901. WOOLSEY, GEORGE, M.D., 117 East Thirty-sixth Street, New York City. Professor of Clinical Surgery, Cornell University; Surgeon to Bellevue Hospital; Consulting Surgeon to Memorial, Peekskill and St. John's Riverside, Yonkers.

1916. YATES, J. L., Ph.B., B.S., M.D., F.A.C.S., 141 Wisconsin Street, Milwaukee, Wis. Chief of Staff, Milwaukee County Hospital; Attending Surgeon, Columbia Hospital.

SENIOR FELLOWS OF THE ASSOCIATION

Abbe, Robert, M.D., 13 West Fiftieth Street, New York.
Armstrong, George E., M.D., C.M., C.M.G., LL.D., D.Sc., 320 Mountain Street, Montreal.

Barton, James M., A.M., M.D., 32 North New Hampshire Avenue. Atlantic City, N. J.
Binnie, John F., M.A., M.B., C.M., 917 Rialto Building, Kansas City, Mo.
Blake, John Babst, A.M., M.D., 311 Beacon Street, Boston, Mass.
Blake, Joseph A., M.D., 116 East Fifty-third Street, New York City.
Bradford, E. H., A.B., M.D., 133 Newbury Street, Boston, Mass.

Carmalt, William H., A.M., M.D., 261 St. Ronan Street, New Haven, Conn.
Carson, Norman Bruce, M.D., 303 Humboldt Building, St. Louis, Mo.
Cushing, Hayward Warren, A.B., M.D., 70 Commonwealth Avenue, Boston, Mass.

Da Costa, J. Chalmers, M.D., 2045 Walnut Street, Philadelphia, Pa.
Dennis, Frederic Shepard, M.D., F.R.C.S. (Eng.), 62 East Fifty-fifth Street, New York, N. Y.

Elliott, John Wheelock, A.M., M.D., 124 Beacon Street, Boston, Mass.
Estes, William Lawrence, A.M., M.D., South Bethlehem, Pa.
Eve, Duncan, A.M., M.D., Eve Building, Nashville, Tenn.

Freeman, Leonard, B.S., M.D., 424 Metropolitan Building, Denver, Col.

Gay, George W., A.M., M.D., 665 Boylston Street, Boston, Mass.

Harte, Richard H., M.D., C.M.G., 1503 Spruce Street, Philadelphia.

Huntington, Thomas W., A.B., M.D., LL.D., 960 Mills Building, San Francisco, Cal.

Hutchinson, James P., M.D., 133 South Twenty-second Street, Philadelphia, Pa.

Johnson, Robert W., A.B., M.D., 101 W. Franklin Street, Baltimore, Md.

Jonas, August F., M.D., 512 McCayne Building, Omaha, Neb.

Kammerer, Frederic, M.D., 51 East Sixty-sixth Street, New York City.

Keen, W. W., A.M., M.D., LL.D., Hon. F.R.C.S. (Eng., Edin. and Ireland), Hon. F.A.C.S., The Touraine, 1520 Spruce Street, Philadelphia, Pa.

Le Conte, Robert G., A.B., M.D., 2000 Spruce Street, Philadelphia, Pa.

‡McMurtry, Lewis S., A.M., M.D., LL.D., 542 Atherton Building, Louisville, Ky.

Martin, Edward, A.M., M.D., LL.D., 135 South Eighteenth Street, Philadelphia, Pa.

Mastin, Wm. M., M.D., LL.D., northeast corner Joachim and Conti Streets, Mobile, Ala.

Meyer, Willy, M.D., 700 Madison Avenue, New York City.

Mixter, Samuel Jason, S.B., M.D., 180 Marlborough Street, Boston, Mass.

Monks, George H., A.B., M.D., M.R.C.S., 51 Commonwealth Avenue, Boston, Mass.

Murray, Francis W., M.D., 32 West Thirty-ninth Street, New York, N. Y.

Ochsner, Albert J., B.S., F.R.M.S., M.D. (Eng.), LL.D., F.A.C.S., 710 Sedgwick Street, Chicago, Ill.

Parmenter, John, M.D., 519 Franklin Street, Buffalo, N. Y.

Pilcher, Lewis S., A.M., M.D., LL.D., 145 Gates Avenue, Brooklyn, New York.

Roberts, John B., A.M., M.D., 313 South Seventeenth Street, Philadelphia, Pa.

Rushmore, John D., M.D., 129 Montague Street, Brooklyn, N. Y.

Scudder, Charles L., A.B., Ph.B., M.D., 209 Beacon Street, Boston, Mass.

Shepherd, Francis J., M.D., LL.D., F.R.C.S. (Eng.), 152 Mansfield Street, Montreal, Canada.

Souchon, Edmund, M.D., 2403 Saint Charles Avenue, New Orleans, La.

Taylor, William J., M.D., 1825 Pine Street, Philadelphia, Pa.

Vander Veer, A., A.M., M.D., Ph.D., LL.D., 28 Eagle Street, Albany, N. Y.

Walker, Edward W., M.D., 214 West Seventh Street, Cincinnati, Ohio.

Warren, J. Collins, M.D., LL.D., Hon. F.R.C.S. (Eng. and Edin.), 58 Beacon Street, Boston, Mass

Watson, Francis S., A.B , M.D., 92 Marlborough Street, Boston, Mass.

Weir, Robert F., A.M., M.D., Hon. F.R.C.S. (Eng.), 1155 Park Avenue, New York, N. Y.

Wharton, Henry R., A.M., M.D., Berwyn, Pa.

Woolsey, George, M.D., 117 East Thirty-sixth Street, New York City.

HONORARY FELLOWS OF THE ASSOCIATION

ELECTED

1907. Ballance, Sir Charles Alfred, K.C.M.G., C.B., M.V.O., M.B., M.S. (Lond.), F.R.C.S., 106 Harley Street, London, W. Consulting Surgeon to St. Thomas's Hospital and to the National Hospital for Paralysis and Epilepsy, Queen Square.

1919. Bastianelli, Raffaelle, Viale della Regina 231, Rome, Italy.

1919. Bowlby, Sir Anthony A., K.C.B., K.C.M.G., K.C.V.O., F.R.C.S., 25 Manchester Square W., London, England. Consulting Surgeon to St. Bartholomew's Hospital and to Queen Alexandra's Military Hospital.

1891. Chiene, John, F.R.C.S. (Edin.), M.D. (Edin.), Aithernie Davidsons Mains, Edinburgh, Scotland. Emeritus Professor of Surgery, University of Edinburgh.

1922. Chutro, Dr. Pietro, University of Buenos Aires, Buenos Aires, Argentina.

1916. Depage, Prof. Dr. Antoine, Hon. F.R.C.S. (Eng.), 75 Avenue Louise, Brussels, Belgium.

1919. Hartmann, Dr. Henri, Hon. F.R.C.S. (Eng.), 4 Place Malesherbes, xvii^{e} Paris, France. Professor de Clinique Chirurgicale, Chirurgien de l'Hôtel Dieu. Membre de L'Académie de Médicine.

1920. Keen, W. W., A.M., M.D., LL.D., Hon. F.R.C.S. (Eng., Edin. and Ireland), Hon. Ph.D. (Upsala), Hon. Sc.D. (Jeff. and Harv.), Hon. F.A.C.S., 1729 Chestnut Street, Philadelphia.

1918. Keogh, Sir Alfred, Hy., G.C.B., Hon. F.R.C.S., The Bungalow, East Grinstead, England.

1922. Leriche, Dr. René, 13 Quai Claude Bernard, Lyons, France.

1894. Macewen, Sir William, M.D., M.B., M.S., 3 Woodside Crescent, Glasgow, Scotland. Professor of Surgery, The University, Glasgow.

ELECTED

1918. Makins, Sir George, G.C.M.G., C.B., LL.D. (Cambridge and Aberdeen), F.R.C.S.

1920. Manoury, Gabriel, Dr., Rue Bonneval 26, Chartres, France.

1908. Moynihan, Sir, B. G. A., Bart., C.B., M.S. (Lond), F.R.C.S., 33 Park Square, Leeds, England. Surgeon to the Leeds Infirmary.

1907. Myles, Sir Thomas, M.D., F.R.C.S.I., 33 Merrion Square N., Dublin, Ireland.

1903. Mayo-Robson, Col. Sir Arthur, K.B.E., C.B., C.V.O., F.R.C.S., D.Sc., Broadoak, Seale, Surrey, Eng.; Consulting Surgeon, King Edward VII Memorial Hospital, Windsor, and Leeds Infirmary. Emeritus Professor of Surgery, University of Leeds; late Vice-President, Royal College of Surgeons and Hunterian Professor.

1912. Stiles, Sir Harold Jalland, M.B., F.R.C.S. (Edin.), 9 Great Stuart Street, Edinburgh, Scotland. Surgeon to Chalmers Hospital and to the Royal Edinburgh Hospital for Sick Children, Edinburgh.

1914. Thomson, Alexis, B.M., M.S., M.D., (Edin.), F.R.C.S. (Eng.), 39 Drumsheugh Gardens, Edinburgh, Scotland. Professor of Surgery, University of Edinburgh.

1918. Tuffier, Th., M.D., Hon. F.R.C.S. (Eng.), 42 Avenue Gabriel, Paris, France.

1920. Wallace, Sir Cuthbert, K.C.M.G., C.B., F.R.C.S., 26 Upper Wimpole Street, W., London, Eng.; Surgeon to St. Thomas's Hospital, London.

1920. Walther, Charles, M.D., 68 Rue de Belle-Chasse, Paris, France. Professeur Agrégé à la Faculté de Médecine; Chirurgien Honoraire des Hôpitaux; Membre de l'Académie de Médecine.

DECEASED FELLOWS OF THE ASSOCIATION

Name	Date of death
Agnew, D. Hayes	March 22, 1892
Allen, Dudley Peter	January 6, 1915
Allis, Oscar Huntington	May 16, 1921
Annandale, Thomas	1907
Ashhurst, John, Jr.	July 7, 1900
*Atlee, John Light	October 1, 1885
Beckman, Emil Hessel	November 7, 1916
Benham, Silas Nelson	November 3, 1890
*von Bergmann, Ernst	Died since 1906 Meeting
*Bigelow, Henry Jacob	October 30, 1890
*Billings, John Shaw	March 11, 1913
*Billroth, Albert Christian Theodor	January 5, 1894
Bontecou, R. B.	1906–1907
Bosher, Lewis C.	September 12, 1920
Briggs, William Thompson	June 13, 1894
Brinton, John Hill	March 18, 1908
Bristow, Algernon Thomas	March 26, 1913
Brock, Hugh W.	April 24, 1882
Bryant, Joseph Decatur	April 7, 1914
*Bryant, Thomas	1914–1915
Bull, William Tillinghast	February 22, 1909
Burrell, Herbert Leslie	1910
Byrd, William Andrew	August 14, 1887
Cabot, Arthur Tracy	November 4, 1912
Campbell, Henry Fraser	December 15, 1891
Cheever, David Williams	December 27, 1915
Cole, Charles Knox	February 27, 1920
Conner, Phineas Sanborn	March 26, 1909
Cunningham, Francis Deane	September 11, 1885
*Czerny, Prof. Dr. Vincenz	October 3, 1916
Dandridge, Nathaniel P.	1911–1912
Davis, Gwilym G.	June 16, 1918

* Honorary.

Name	Date of death
Davis, John Staige	July 18, 1885
Dawson, William Wirt	February 16, 1893
Dugas, Louis Alexander	October 19, 1884
Dunn, James Henry	June 16, 1904
Dunott, Thomas Justus	May 20, 1893
*Durham, Arthur Edward	May 7, 1895
*Erichsen, Sir John Eric	September 23, 1896
*von Esmarch, Friedrich	1907
Fenger, Christian	March 7, 1902
Ferguson, Alexander Hugh	October 20, 1911
Forbes, William Smith	December 17, 1905
Fowler, George Ryerson	February 6, 1906
*Friedrich, Paul Leopold	January 5, 1916
Gaston, James McFadden	November 17, 1903
Gerrish, Frederic Henry	September 8, 1920
Gerster, Arpad G.	March 11, 1923
*Gorgas, William C.	July 4, 1920
Greene, W. Warren	September 10, 1881
Gross, Samuel David	May 6, 1884
Gross, Samuel Weissel	April 16, 1889
Gunn, Moses	November 4, 1887
*Gussenbauer, Karl	June 19, 1903
Guthrie, George Washington	June 1, 1915
Halsted, William Stewart	September 7, 1922
Harrington, Francis B.	1914–1915
*Harrison, Reginald	1907
Hearn, W. Joseph	December 20, 1917
Hodge, H. Lenox	June 16, 1881
Hodgen, John T.	April 28, 1882
Homans, John	February 7, 1903
*Horsley, Sir Victor Alexander, C. B.	July 16, 1916
Horwitz, Orville	January 28, 1913
*Horwitz, Phineas J.	September 28, 1904
Hughes, J. C.	August 10, 1881
*Humphrey, Sir George Murray	September 24, 1896
*Hunt, William	January 5, 1897

* Honorary.

Name	Date of death
Jacobson, Nathan	September 16, 1913
Johnson, Alexander B.	September 4, 1917
Johnston, George Ben	December 20, 1916
Johnston, Christopher	October 11, 1891
King, Alfred	June 4, 1916
Kinloch, Robert Alexander	December 23, 1891
*Kocher, Theodor	July 27, 1917
Lane, Levi Cooper	February 18, 1902
*von Langenbeck, Bernhardt	September 30, 1887
Levis, Richard J.	November 12, 1890
*Lister (Lord), Joseph	February 11, 1912
Little, James Lawrence	April 4, 1885
Lutz, Frank Joseph	March 24, 1916
McCann, James	1893
McCosh, Andrew J.	December 3, 1908
McGraw, Theodore A.	September 6, 1921
McGuire, Hunter	September 19, 1900
McRea, Floyd W.	August 13, 1921
*MacCormac, Sir William	December 4, 1901
MacDonald, Willis Goss	December 30, 1910
Mackenzie, Kenneth Alexander James	March 15, 1920
MacMonagle, Beverly	May 22, 1912
Markoe, Francis Hartman	1907
Marks, Solon	1916
Mastin, Claudius Henry	October 3, 1898
Mears, J. Ewing	May 28, 1919
Michael, J. Edwin	December 7, 1895
*Mikulicz-Radecki, John V.	
Miles, Albert B.	August 5, 1894
Millard, Perry H.	February 1, 1897
Miller, Truman W.	May 31, 1900
*Moore, Edward Mott	March 3, 1902
Moore, James E.	November 2, 1918
Mudd, Henry Hodgen	November 20, 1899
Mumford, James Gregory	October 18, 1914
Munro, John C.	December 6, 1910
Murphy, John B.	August 11, 1916

* Honorary.

Name	Date of death
de Nancrède, C. B. G.	April 12, 1921
Nichols, Edward Hall	July 6, 1922
Norris, Basil E.	October, 1895
*von Nussbaum, J. N.	October 31, 1890
*Ollier, Leopold	1900–1901
Oviatt, Charles W.	October 31, 1912
Owens, John E.	December 21, 1922
*Paget, Sir James	December 30, 1899
Pancoast, William H.	January 5, 1897
Park, Roswell	February 15, 1914
*Parker, Willard	April 25, 1884
Parkes, Charles T.	March 28, 1891
Parkhill, Clayton	January 16, 1902
*Péan, Jules E.	January 30, 1898
Peck, Washington F.	December 30, 1891
Pilcher, Paul Monroe	January 4, 1917
Porter, Charles Burnham	May 21, 1909
Porter, William Gibbs	January 30, 1906
Powers, Charles A.	December 23, 1922
*Pozzi, Samuel	1918
Prewitt, Theodore F.	October 17, 1904
Prince, David	December 19, 1889
Ransohoff, Joseph	March 10, 1921
Reed, Thomas Baird	April 1, 1891
Richardson, Maurice Howe	July 31, 1912
Richardson, Tobias Gibson	May 26, 1892
Rodman, William Louis	March 8, 1915
Ross, George Gorgas	December 27, 1922
Sabine, Thomas Taunton	August 23, 1888
Sayre, Lewis A.	1900–1901
*Schede, Max	1902
Senn, Nicholas	January 2, 1908
Sherman, Harry M.	1921.
*Sims, J. Marion	November 13, 1883
*Smith, Stephen	August 26, 1922
Squire, Truman Hoffman	November 27, 1889
Stewart, Francis T.	February 4, 1920

* Honorary.

Name	Date of death
*Terrier, Louis Felix	1908
*Thiersch, Karl	April 28, 1895
Thompson, Joseph Ford	February 1, 1917
Thompson, Joseph W.	March 30, 1886
Thomson, William	August 3, 1907
Tiffany, Louis McLane	October 23, 1916
Varick, Theodore Romeyn	November 23, 1887
*Verneuil, Aristide A. S.	June 11, 1895
*von Volkmann, Richard	November 28, 1889
Watson, Beriah Andrew	December 22, 1892
Weeks, Stephen Holmes	September 1, 1909
Weist, Jacob Rowland	May 14, 1900
*Wells, Sir Thomas Spencer	January 31, 1897
White, James William	April 24, 1916
Wight, Jarvis S.	November 16, 1901
Willard, DeForest	October 14, 1910
Wood, James R.	May 4, 1882
*Yandell, David Wendell	May 2, 1898

* Honorary.

REPORT OF COMMITTEE ON NECROLOGY

DR. EDWARD H. NICHOLS

Edward H. Nichols, associate professor of surgery in Harvard Medical School, surgeon-in-chief at the Boston City Hospital, and a member of the American Surgical Association, died in Boston on July 6, 1922.

He was born in Reading, Mass., on January 6, 1864. His father was Edward C. Nichols and his mother Abbie Susan Wall Nichols. He married at Cambridge, Mass., on October 3, 1894, Edith Walker Judd, who survives him, as do a son, Hall B. Nichols, born July 14, 1895, and a daughter, Edith Greenleaf Nichols.

Dr. Nichols was graduated from Harvard College in 1886. While at college he took a high stand in his studies and became one of the best baseball pitchers Harvard ever had. He had a keen, quick mind and a habit of rapidly and completely sizing up a situation, which made him a good baseball player, while these same qualities may have been increased and developed by the training of the game. After leaving college he continued a keen interest in athletics. As coach of the baseball team, and later as a member of the baseball committee, his wise judgment contributed much to the success of the Harvard teams. For many years he was surgeon-in-charge of the football team. He was wise and conservative in his care of the injured members and never let the pleading of a coach or captain induce him to return a player to active duty before he was fully recovered. His skill and courage in the face of opposition did much to bring the team to the final game in winning form. He took almost parental interest in the boys under his charge.

After graduation from the Medical School, Dr. Nichols was assistant superintendent at the Boston City Hospital, and soon after leaving the hospital was appointed out-patient surgeon, serving through the various grades until he became surgeon-in-chief. He was a thorough student of surgical pathology, and at first was instructor and later assistant professor of surgical pathology. Later he became first associate professor, and finally, in 1916, clinical professor of surgery.

From 1899 to 1905, Dr. Nichols gave up his private practice to

become director of the Cancer Laboratory of the Croft Research Fund, and threw himself into the work with the greatest interest and enthusiasm. He resumed private practice, which he continued with ever-increasing success until 1915, when he volunteered to have charge of the First Harvard Unit, which went overseas to serve with the British as Base Hospital No. 22, in France. His intelligent leadership contributed greatly to the successful launching of this enterprise, which was continued under other leadership to the end of the war. In 1917 he went to France as surgeon-in-chief of Base Hospital No. 7, the City Hospital Unit, where he served at Tours until the end of the war, his service being varied by trips to the Front with operating teams. His story was in brief the life-history of a brilliant, energetic, conservative surgeon, who, starting life with no other capital than his own brain, made a conspicuous success, and at the same time was ready to abandon his selfish interest, first at the call of science and second of his country.

He was well equipped for his work as a surgeon by decision of character, intense interest, thorough and hard training in pathology, absolute intellectual honesty and frankness in acknowledging mistake or error. His knowledge of hospital organization made him a valued member of the staff and gave him great influence in hospital affairs. He loved the students and liked to spend time in giving them individual instruction, as well as his lectures and demonstrations. Not only in surgery but in many other affairs of life younger men sought his advice, which was usually sound and always disinterested. He was a scientific searcher after facts and a hater of ostentation and pretence. For social life outside his profession he had little time, but made many friends in connection with his many activities.

He was a member of this Association and of the American Association of Pathologists and Bacteriologists; at one time of the Society of Clinical Surgery and of the American Medical Association.

Among his more substantial contributions to surgical pathology and literature may be remembered his work on *Osteomyelitis*, etc. His writings were characterized by scientific accuracy, and at medical meetings he never spoke unless he had something to say. He made numerous and valuable contributions to surgical literature. They appeared in surgical and medical journals, in Keen's *System of Surgery* and in the reports of the hospitals and commissions with which he was associated.

He was an enthusiastic yachtsman and spent his vacations usually sailing around the southern coast of New England.

By his death Harvard University lost a brilliant teacher, his hospital a surgeon of good judgment and surgical acumen, his profession a gifted and useful practitioner. F. B. L.

DR. STEPHEN SMITH

Stephen Smith, A.M., M.D., LL.D., Honorary Fellow of the American Surgical Association, was born February 19, 1823, at Spafford, N. Y. He was graduated from the College of Physicians and Surgeons, New York, in 1851. He died August 26, 1922.

The life of Dr. Stephen Smith gives a remarkable example of a surgeon of great ability as an operator, a teacher and a writer, who was still preëminent as a good citizen.

As a practical surgeon it may be noted that he was appointed visiting surgeon to Bellevue Hospital in 1854, when thirty-one years of age – only three years after his graduation in medicine. He was appointed attending surgeon to the City Hospital in 1864; St. Vincent's Hospital in 1885 and to Columbus Hospital in 1890, and during the Civil War he worked as volunteer surgeon in the Government Hospital at Fortress Monroe and in the Military Hospital in Central Park, New York.

The three editions of his book, *The Principles and Practice of Operative Surgery*, were standard in their time and met with a sale of considerably more than twenty thousand copies. His method of amputation at the knee-joint is widely known and is still in use.

As a teacher, following the method of holding private classes which was in vogue in his time, he soon had as many as sixty students in a single class at Bellevue Hospital. Appreciating the clinical possibilities which Bellevue Hospital offered, he joined with Dr. Sayre and Dr. Isaac Taylor in organizing the Bellevue Hospital Medical School, which began its work in 1861 with one hundred and fifty students. He was professor of the principles of surgery and clinical surgery there in 1861 to 1865, and professor of anatomy in 1865 to 1872. After his resignation, in 1872, he was professor of clinical surgery in the New York University Medical School.

In addition to his book on operative surgery, he wrote many valuable articles for the medical and surgical journals; he was sole editor of the *New York Journal of Medicine;* also, at a later time, editor of the *Medical Times and Gazette*. His editorials in this journal showed a broad view of the doctor as a citizen and were published in a separate volume of four hundred pages.

With these manifest talents as practical surgeon, teacher and writer, one would naturally expect that Dr. Smith's life would mainly be given to these activities, but such was not the case. He was primarily a good American citizen, with an inherent desire to serve and benefit the commonwealth of which he was a part. His mind quickly turned

to the problems of public health in their broadest scope. During his early hospital work he had abundant and even heart-racking experiences when epidemics of typhus fever, yellow fever, cholera and smallpox in turn appeared. When a succession of two hundred cases of typhus fever patients came to Bellevue Hospital from a single house, in East Twenty-first Street, he tried to correct the deplorable conditions there and found that there were no laws to meet the situation. With the help of William Cullen Bryant and the threat of editorial and news publicity in the *Evening Post*, the landlord was brought to terms. It may be fairly said that the organization of the New York Board of Health was an outgrowth of this incident. The State Board of Health and the National Board of Health soon followed, and he was influential in the establishment of both. In 1868 he was appointed Commissioner of Health by Governor Fenton. In 1872 he was appointed Commissioner of Health for the city by Mayor A. Oakley Hall, and he was later reappointed by Mayor Havemeyer. In 1870 he was the first president of the American Health Association and was reëlected four times. In 1879 he was appointed a member of the National Board of Health by President Hayes. In 1894 he was appointed delegate to represent the United States in the International Sanitary Conference.

An indication of the extent of his public service is shown by the fact that he was appointed to office three times by the mayors of New York, seven times by the Governors of the State of New York and twice by the Presidents of the United States. He was a member of the State Board of Charities, 1893 to 1918, when he resigned at the age of ninety-five. It is said that he was present at ninety-six meetings of this board in a consecutive series of one hundred meetings. He also was one of the incorporators of the New York Infant Asylum and assisted in organizing the Foundling Asylum. He was also State Commissioner in Lunacy, and inaugurated reforms which were most important. Dr. Smith continued his public service far beyond the term of life which is given to most men. He lived ninety-nine and one-half years.

Last year, in his presidential address, Dr. Finney emphasized the demand for public service which the commonwealth may justly make upon the surgeon. Dr. Stephen Smith has shown in wonderful degree the public service which a surgeon can render if his organizing and executive talents and his energies are given to the problem.

C. N. D.

DR. WILLIAM STEWART HALSTED

William Stewart Halsted, M.D., Sc.D., LL.D., Hon. F.R.C.S., F.A.C.S., professor of surgery in Johns Hopkins University and surgeon-in-chief to Johns Hopkins Hospital, was born in the city of New York, on September 23, 1852, and died in Baltimore on September 7, 1922. He was of English ancestry and descended from a family prominent in the social, business and philanthropic life of New York.

He prepared for college at Phillips Academy, Andover, Mass.; was graduated from Yale University with the A.B. degree in 1874; studied medicine in the College of Physicians and Surgeons, New York, and was graduated in 1877 at the head of his class. He served as intern in the Bellevue Hospital and in the New York Hospital, and studied two years in Europe; and after his return to New York became demonstrator in anatomy in the College of Physicians and Surgeons, which position he filled with great distinction until 1885.

He began the practice of surgery in the fall of 1880. Besides other surgical appointments, he was appointed as attending surgeon to the Presbyterian and Bellevue Hospitals and assistant to the attending surgeon of the Roosevelt Hospital.

He organized a corps of teachers for the extramural instruction of medical students, and was so successful that in one graduating class ten out of the first twelve men were members of his "quiz."

Thus his subsequent contributions to the science and art of surgery, as author, investigator, teacher and trainer of men, were but the natural fulfilment of the early promise exhibited in his brilliant achievements during this busy period of his career in New York.

As a direct result of the character and extent of his work during this period, his health suffered and he was compelled to relinquish his work for a time. His health having improved, he (in 1887) came to Baltimore as one of that brilliant coterie of men who had been attracted thither by the opportunities offered in the newly opened pathological laboratory of Johns Hopkins University under the inspiring leadership of Dr. Welch. Here he became at once identified with and a leading spirit in the new Johns Hopkins School of Medicine. In the early days of this development he was associated with such brilliant pupils of Dr. Welch as Mall, Councilman, Nuttall, Walter Reed, Abbott, Flexner and many others of like mind. No wonder then that Dr. Halsted, with his splendidly trained mind, his scientific curiosity and his wide experience and interest, developed rapidly in this congenial atmosphere, and was not long in embarking upon his remarkable career of scientific productiveness.

His scientific enthusiasm, the thoroughness of his methods and his

absolute truthfulness impressed themselves on the school of surgery which he founded. It made no difference whether or not the truth, when finally discovered, confirmed or overthrew his preconceived ideas or previously enunciated theories. His absolute honesty made him always the first to call attention to his own mistakes. The painstaking care, however, with which his work was planned and the scientific accuracy with which it was performed made this rarely necessary.

Dr. Halsted has expressed himself upon more than one occasion as convinced that the best result of his arduous labor was the development of a group of younger surgeons trained under him in modern scientific methods and thoroughly imbued with the same high ideals of surgical honesty. Among all of his contributions he personally attached greatest importance to the law discovered and enunciated by him in connection with the investigations of the action of parathyroid autografts in the dog, namely, "That unless considerable deficiency in parathyroid tissue has been created the autografts do not live."

Surgical literature has been continuously enriched by the many thoughtful and erudite studies that have come from his laboratory. This was truly his workshop, for the clinical side of his work interested him comparatively little, although all of his publications had a very practical application, many of them preëminently so, for example, his introduction of the use of rubber gloves in surgery, his insistence upon the most meticulous care in the gentle handling of tissues, absolute asepsis, complete hemostasis, etc.

Personally, "The Professor," as he was familiarly called by his staff, was a curious mixture of contradictions: Abnormally shy and sensitive as a woman; to a stranger reserved to a degree, and yet to his few intimates the most charming of companions; endowed with a keen yet kindly sense of humor, and at the same time with a wit that upon occasion could be caustic in the extreme. To his associates and assistants he was always stimulating and helpful, even if at times he may have felt it necessary for their good to apply the Biblical adage, "Faithful are the wounds of a friend."

The number of his publications reaches well over a hundred, all valuable, and many original pieces of research, and some epoch-making, *e. g.*, his work upon the radical cure of cancer of the breast and of inguinal hernia, nerve-blocking, etc.

Dr. Halsted has, by the wide range and excellent character of his work, given prestige and renown to American surgery and earned the right to have his name enrolled among those of the great immortals. To scientific surgery; to the institutions with which his name has become inseparably connected; to his pupils and friends who enjoyed the inestimable privilege of his inspiring companionship, his death means an irreparable loss. J. M. T. F.

DR. JOHN EDWIN OWENS

John Edwin Owens, a Senior Fellow of the Association, died at his home in Chicago, December 21, 1922.

Dr. Owens was born at Charlestown, Md., October 14, 1836, and received his preparatory education in his native state. He took his medical course in Jefferson Medical College, Philadelphia, receiving his degree in 1862.

After a service as assistant physician at Blockley Hospital, Philadelphia, he enlisted in the Medical Corps of the Union Army, and from 1863 to 1865 was on duty in a military hospital in Chicago.

Dr. Owens was the first attending surgeon at St. Luke's Hospital, Chicago, having been appointed to that position in 1865, and retaining it until 1912, at which time he became consulting surgeon.

He had a long career as a teacher of surgery, lecturing successively in Rush Medical College, the Woman's Medical College and the Chicago Medical College (now the Northwestern University Medical School), remaining active in the latter institution until advancing age made it difficult to fulfil the duties of his position, at which time he was honored with the appointment of emeritus professor of surgery, which he held until his death.

Dr. Owens was for many years chief surgeon both of the Illinois Central and Chicago and Northwestern Railroads. He was medical director of the World's Columbian Exposition, Chicago, from 1891 to 1893.

He was a Fellow of the American College of Surgeons and was active in surgical societies, especially those of railroad surgeons. In 1900 he was vice-president of the American Surgical Association.

Dr. Owens married Alethea Sophia Jamar in 1869. Mrs. Owens died in 1919. Dr. Owens had but one child, Mrs. John Crerar, who survives him.

Such is the brief statement of Dr. Owens' professional activities—an admirable record, but giving no idea of his delightful personality, lofty personal and professional standards and the high regard in which he was held by his confrères.

Dr. Owens was instinctively looked up to as the highest type of gentleman, and was entitled not only by birth but by habitual consideration for others to that more delicate appellation, "Southern gentleman."

In the various executive positions which he filled, his management proved his executive ability; but he accomplished his ends by tact, diplomacy and gentle force, never resorting to methods which would

bring discomfort or annoyance to those with whom he had to deal. He was regarded first as a friend, then as a commanding officer.

As a teacher he was clear and emphatic; what he wished to convey was brought home to the student in an impressive way which helped the memory to retain it. An ever-present vein of quiet humor endeared him to his students.

The way in which he was looked up to by his colleagues is shown by the fact that when the Chicago Surgical Society was founded, in 1900, he was elected as its first president, and when the American Association of Railway Surgeons was organized, in 1905, he was also chosen as its first president.

For many successive years he was unanimously elected president of the medical board of St. Luke's Hospital, Chicago. No other candidate was ever considered until the infirmities of age made it necessary for Dr. Owens to relinquish the position.

One of the most interesting capacities in which Dr. Owens served was as medical director of the World's Columbian Exposition. Dr. Owens was appointed to this position in 1891, when building operations were begun. A large number of men were employed in construction work, many of them living on the grounds. At one time the number of employees rose to nearly ten thousand. During the exposition, employees and visitors were taken care of in an emergency hospital located on the grounds. This position called upon Dr. Owens for ability, not only as a surgeon and as an executive, but as a sanitarian. It was necessary to deal with people of all occupations and professions, as well as of all nationalities, and in no position which he occupied did he show better his unfailing tact and diplomacy.

Dr. Owens will be missed as one of the outstanding personalities in the medical profession of Chicago, a man beloved by all for his personal qualities and revered by all for his excellent attainments.

S. C. P.

DR. CHARLES ANDREW POWERS

Charles Andrew Powers was born in Lawrence, Mass., February 2, 1858, and died in Denver, Col., of a cerebral hemorrhage, December 23, 1922. He was graduated from the College of Physicians and Surgeons, in New York, in 1883, and, following an internship, completed his postgraduate studies in the clinics of Paris, Heidelberg and London. He began the practice of surgery in the city of New York, where his superior attainments were soon recognized, obtaining

for him many friends as well as a number of responsible positions, such as attending surgeon to the Cancer Hospital and to St. Luke's Hospital.

For reasons connected with his health, Dr. Powers moved to Denver in 1894, where his professional and social successes were rapid and pronounced. He soon became professor of surgery in the medical department of the University of Colorado, and at various times was surgeon to most of the hospitals in Denver.

In 1908 he joined the Medical Reserve Corps, with the rank of first lieutenant. Soon after the beginning of the World War, Dr. Powers, whose sympathies were strongly with the French, retired from civil practice and became attending surgeon to the American Ambulance Hospital in Paris, remaining abroad, with few interruptions, during the entire period of hostilities.

On July 22, 1917, he was given a majority in the Medical Corps of the United States Army and assigned to duty in American Hospital No. 1, at Neuilly, receiving an honorable discharge on December 5, 1918. On returning home he became a lieutenant-colonel in the Medical Reserve Corps.

In recognition of his services abroad, he was awarded the Médaille de la Reconnaissance Française, elected a Chevalier of the Legion of Honor of France and an officer of the Order of Leopold II of Belgium. At his funeral services in Denver, December 26, 1922, the Distinguished Service Medal was pinned upon the uniform in which he was buried by a representative of the War Department. His friends regret deeply that he could not have received this honor before his death, which he would have done had he lived only a few days longer. His body was sent to Washington and interred with military honors in Arlington Cemetery.

Dr. Powers was elected a Fellow of the American Surgical Association in 1896, and became its president in 1912. He was also a Fellow of the American College of Surgeons and a member of the International Surgical Society, American Society of Clinical Surgery, Colorado State Medical Society, Denver City and County Medical Society, American Medical Association and the American Society for the Control of Cancer, of which he was the very efficient president.

Four things in Dr. Powers' life were especially dear to him: His profession, the American Surgical Association, his military medical service and the Society for the Control of Cancer.

Professionally he was a good surgeon, noted more, perhaps, for his caution and judgment than for brilliancy in operating. His pronounced diagnostic ability was based upon wide reading and experience, aided by keen powers of observation and an analytic mind. He

was an excellent teacher and contributed many able articles to surgical literature which helped to make him a prominent figure in surgery both at home and abroad.

Dr. Powers was proud of his connection with the American Surgical Association, and his intimate friendships with its members meant more to him than almost anything else. He constantly endeavored to make his professional conduct measure up to the high standards of the Association, which sometimes may have made him unduly critical of the shortcomings of others. He had many firm and loyal friends, throughout this and foreign countries, who were attracted to him by his ability and his many agreeable social qualities. Against those who displeased him he often used a certain polished sarcasm which sometimes procured for him quite bitter enemies.

That his services in the World War were of great value is shown by the honors conferred upon him by France and Belgium, as well as by a laudatory letter written to him personally by General Pershing. Dr. Powers once said to me that his military service was what he most desired as a fitting termination to his professional career, and that it came at an opportune time, just as he was ready to retire from civil practice. His work in France was mostly in reconstructive surgery of the face, in which he manifested distinctive ability.

Upon his return from Paris after the Armistice, Dr. Powers was chosen president of the Society for the Control of Cancer, and devoted himself exclusively to the interests of that association. It is largely to his effective and unselfish efforts that the society owes its success in the publicity campaign against malignant diseases, thus rendering an inestimable service to mankind.

In the death of Dr. Powers, the American Surgical Association has lost a valuable and devoted member. L. F.

DR. GEORGE GORGAS ROSS

George Gorgas Ross was born in Philadelphia, July 9, 1866, and died there from complications following an attack of influenza, December 27, 1922, aged fifty-seven years. He was survived by his widow and two daughters. He was the son of Joseph Ross, of Middletown, Pa., and Mary Bowman, and through his maternal grandmother, Sarah Gorgas Bowman, was descended from the well-known Pennsylvania family Gorgas, whose most distinguished member was the late Surgeon-General of the Army.

Acquiring his early education in the public schools of his native city, Dr. Ross entered business for a time, but later matriculated in the University of Pennsylvania, and received, in 1888, a certificate of proficiency in biology. A third of a century later (1921) the trustees of this institution conferred on him the degree of bachelor of science as of the class of 1888, testifying by this act to their appreciation of his postgraduate career. While an undergraduate in college, Ross played football, rowed on the "Varsity" crew and became a member of the Psi Upsilon fraternity. He attended the medical school of his Alma Mater for three years, graduating as Doctor of Medicine with the class of 1891. Among his classmates were Beyea, Bloodgood, J. G. Clark, George Fetterolf, A. O. J. Kelly, Nassau, Joseph Sailer, William T. Shoemaker and George C. Stout.

After graduation he served as resident physician in the German (now Lankenau) Hospital. In 1895 he was elected a chief of the out-patient surgical department of this hospital, and in 1897 assistant surgeon, both of which posts he filled acceptably until his death.

His other hospital connections were numerous and important. From 1902 until his death he was surgeon to the Germantown Hospital, witnessing and largely aiding in its phenomenal growth during that period. When Dr. John B. Deaver was elected, in 1911, professor of the practice of surgery in the University of Pennsylvania, Dr. Ross was one of those he brought with him, and he served first as instructor, later as associate in surgery, until Prof. Deaver's retirement in 1922; also acting as assistant or associate surgeon to the University Hospital for the same period. He was surgeon to the Stetson Hospital from 1911 until his resignation in 1920 and to the Methodist Hospital from 1919 until his death.

In 1918 he accompanied overseas the Methodist Hospital Navy Base Unit, acting as chief of the surgical service and seeing much active work at the front while in France. He was transferred to the Naval Reserve Force, with the rank of commander, and on December 12, 1919, he was awarded the Navy Cross.

In 1898 he was elected a Fellow of the College of Physicians of Philadelphia and in 1900 a Fellow of the Philadelphia Academy of Surgery. He became vice-president of the Academy of Surgery in 1916, and served as its president in 1920 and 1921. He had held Fellowship in the American Surgical Association since 1914.

Dr. Ross had a large and active practice, scattered throughout the city and its suburbs, and he worked hard at this and at his hospitals and his teaching. He was a careful and safe if not a brilliant operator, and, what was of even more importance, he was an excellent diagnostician and good general surgeon. He found time to take an active

interest in the meetings of the Academy of Surgery and frequently brought forward case reports of value and interest. He never exhibited any tendency to specialize his work, but perhaps was more interested in abdominal surgery and in hernia than in surgery of the extremities. Yet probably his name will be remembered by posterity more from his papers relating to sprains and to sprain-fractures than from those, excellent as they were, which discussed subjects in visceral surgery.

He was an ardent devotee of golf, and his relapse and fatal illness, perhaps, were attributable to overexertion at this sport while not yet fully convalescent. His was a most genial and kindly personality; he made friends easily and never lost them; everyone liked him, and his sudden and unexpected loss left a void which will never be filled.

A. P. C. A.

DR. ARPAD G. GERSTER

Arpad G. Gerster, son of Nicholas Gerster and Caroline Schmidt-Sandy, was born in Kassa, Hungary, on December 22, 1848, and died in New York, March 11, 1923, at the age of seventy-four years. He was the brother of Etelka Gerster, who achieved great fame as a coloratura soprano in grand opera. Dr. Gerster's preliminary education was completed in the schools of his native country, and he was graduated in medicine from Vienna in 1872. He came to America on March 9, 1873. On December 14, 1875, he married Miss Anna Barnard Wynne, in Cincinnati, who, with their son, Dr. John C. A. Gerster, survive him. The early days of his practice were passed in Brooklyn.

The following is a list of the organizations of which he was a member or an officer:

October, 1877, Member of German Dispensary, New York.

December, 1877, Chief of Surgical Division, German Dispensary.

December 26, 1878, Attending Surgeon, German Hospital, New York.

June 13, 1880, Attending Surgeon, Mount Sinai Hospital, New York.

October 15, 1882, Professor of Surgery, New York Polyclinic.

October 24, 1882, Member of New York Surgical Society.

May 15, 1890, Fellow of American Surgical Association.

October, 1890, Member of Century Association.

April, 1891, Member of German Association of Surgery, Berlin.

November, 1891, President of New York Surgical Society.

December, 1891, Corresponding Member of Royal Medical Society, Budapest.

January, 1896, Vice-President of Medical Board of Mount Sinai Hospital.

November, 1896, Consulting Surgeon to German Hospital, New York..

May, 1908, Vice-President of American Surgical Association.

March, 1909, President of Charaka Club, New York.

March 7, 1916, Professor of Clinical Surgery, Columbia University.

February 11, 1911, First Lieutenant, U. S. Army Medical Reserve Corps.

May 12, 1912, Trustee of Association for the Protection of the Adirondacks.

June, 1911–1912, President of American Surgical Association.

January 1, 1914, Consulting Surgeon of Mount Sinai Hospital (by age limit).

April 6, 1916, Trustee of New York Academy of Medicine.

Dr. Gerster was a prolific and powerful writer, whether his subject was connected with his profession or dealt with some other branch of science, with art or with music, or with life in the open, which formed his greatest diversion and recreation.

His book entitled *The Rules of Aseptic and Antiseptic Surgery*, published by Appleton in 1888, was in those days a veritable edition de luxe, printed on heavy calendered paper, with many illustrations by the halftone process, at that time rare or even unique in its application to scientific books. In order to make these illustrations, Gerster became a photographer, making his own plates and mastering the technic at a time when photography was far less universally practised by the amateur than it is at present. The book was of immense educational value and became extremely popular, passing through three large editions in less than two years.

He was a pioneer in advocating continuous service in the surgical department of hospitals, against the former alternating service with its comparative lack of responsibility and its defects in teaching standardized methods to the younger men.

Gerster was a man of particularly broad interests. In addition to his chosen calling, in which he was eminent, he became an amateur etcher whose work excited the interest of professionals in the art. The curator of prints at the New York Public Library happened to see some of Dr. Gerster's work in the collection of the late Dr. Le Roy Milton Yale, himself an etcher, who had left his collection to the institution. At the request of this official, Dr. Gerster presented a proof of each of his etchings to the library.

As his power for physical work diminished, he gave more and more time to writing and to painting in oils, a branch of art in which he was making notable progress almost to the time of his death. *The Freeman* (New York, February 21 and 28, 1923) published articles from his pen in which he strongly defended the more classical forms of painting against the ultramodern tendency to the employment of striking color masses and combinations to the detriment of beauty of form, and he received many letters commending his fearless and powerful stand. As a surgeon, his work is internationally known.

As a diagnostician and adviser, his counsel was in great demand; as an operator, he was one of the most brilliant. As a practitioner, kindness and conscientiousness were his prominent virtues.

Dr. Gerster's powerful and beneficent influence will always live through his colleagues, his students and his many friends.

H. L.

ADDRESS OF THE PRESIDENT

REPAIR OF THE COMMON BILE-DUCT

By LEWIS L. McARTHUR, M.D.
CHICAGO, ILL.

Following a precedent early established in this Association, the chairman's address has involved the presentation of some living problem of surgical interest. Permit me this morning, therefore, to invite your consideration of the still debatable question of "Common Bile-duct Repair." My remarks will be accompanied by some *x*-ray photographs illustrative of the method advocated. Several years more experience with a procedure advocated by me elsewhere serves to confirm the speaker's convictions, that, while not yet perfect, it offers the most rational and efficient method yet devised for the correction of these most distressing complications in bile-tract surgery—stricture or loss of continuity. Disease, accident or neoplasm may result in such stricture or loss of continuity of this duct as will compel efforts on the part of the surgeon to reëstablish a permanently patulous channel for the free flow of bile to the duodenum or the stomach. The procedure is necessarily modified by the causative factor in its destruction, the location of loss of lumen and the condition of the surrounding field of operation. Unfortunately, it occurs so much more frequently as a sequel to former surgical invasion of the bile tracts for disease and resultant stones that a certain stigma rests upon the surgeon, though generally unmerited.

Search through the literature reveals many methods that have been suggested for the relief of this condition, the majority affording only indifferent success. Ellsworth Eliot has made a masterly review of the entire subject. Here, in the home of bile-duct surgery, *particularly* must attention be called to the recommendation of Dr. William Mayo, who has successfully reconstructed the missing portion of the duct out of a tongue-like flap of all three layers of the adjacent bowel or stomach, converting it into a tube; its free end has been sutured to the proximal end of common duct, and the opening in the hollow viscus closed as thoroughly as possible about the base of the pedicle. Walton has made similar recommendations, and finds no harmful effects when using the stomach as the site of drainage. Hertzler has utilized a portion of the gall-bladder, so cut as to supply a tubular flap to repair duct. But the gall-bladder is usually absent in cases requiring repair, and when present can be more simply used by an anastomosis with the duodenum direct, thus making a by-pass for the bile.

Fascial transplants have been used with occasional success in the animal experimentations, but all too frequently result in failure when the same are utilized in the pathological common duct. The earliest recorded case I could find of an attempt to reconstruct over a tube a common duct was that of Jenckel, November, 1905, who endeavored to reconstruct a duct by suturing one end of a rubber tube in the common duct, then inserting the other end in the duodenum after the Witzel method for *temporary* gastric or jejunal fistula, that is, by burying the tube by suture in a fold of the duodenal wall for one or two inches before perforating that wall. The chief value and point in Witzel's procedure was to produce a temporary channel that would close with the removal of the tube. The very thing to be avoided then in establishing a new common duct! In fact, in the case mentioned, Jenckel, three weeks after operation, inserted his finger into the fistulous tract to remove the tube. Traction on it tore open the duodenum along the Witzel suture, with a resulting desperate duodenal fistula and extremely tedious

convalescence. Strangely enough, after months, the wound epithelialized sufficiently internally before it closed externally to establish a nexus between proximal stump of duct and duodenum! After more than a year's time, the patient was discharged cured.

In October, 1907, I relieved temporarily a chronic intermittent jaundice with fistula, by excision of the fistula, removal of a somewhat dilated remnant of a cystic duct with stones, and

FIG. 1.—Schematic drawing, showing catheter placed in common duct through both proximal and distal ends into the duodenum.

removal of stones and grit from the common duct at the junction of cystic with common. A probe was passed down freely into duodenum, which when palpated revealed the distal portion of duct surrounded by much indurated and cicatricial tissues. Duct was dilated above site of stones, but, being patulous to fluids and to probe, no effort was made to dilate the narrowed portion. A small soft-rubber catheter was passed down the duct well into the duodenum and the wound closed about the catheter. Recovery uneventful: healing in seven weeks.

Nine months later, after several recurrent attacks, chills, fever, and jaundice, patient was reopened. Stricture found about site of former opening, the duct this time being opened nearer duodenum. Probe passed easily downward through ampulla. Efforts to pass same upward met with failure, except with fine Bowman's probe. Splitting of stricture and excision of scar-tissue revealed duct dilated above to easily admit No. 16

FIG. 2.—Shows *x*-ray picture of tube in the common duct. This was one of the earlier cases operated and took nine weeks to be discharged *via* the intestines.

English sound. Insertion upward in proximal dilated duct of a rubber tube was made, the end of which had a double reverse cuff enlargement, and fastened in place by a twenty-day chromic encircling suture. The free end of the tube was carried well into the duodenum through the distal duct and ampulla, so that six to eight inches protruded into the duodenum; the ends of duct were approximated with fine catgut sutures. Wound

closed with cigarette drain down to line of duct suture. No bile leakage through wound.

At this point, let me express the agreeable surprise that has been mine in most of these cases, namely, that the majority of them have leaked no bile at all, though there had been no thought of a hermetic suture, as evidenced by the fact that drainage was always provided for. With the flow so freely possible through

FIG. 3.—Shows tube in common duct and duodenum, taken with barium meal in stomach, and shows relationship of tube to pylorus and duodenum. This tube is also shorter than those now recommended.

the catheter into the duodenum, it would appear that there existed an almost negative pressure in the common duct. This has been equally true when—unable to find or utilize the distal portion of the duct—the catheter has been inserted through a simple opening in the wall of the duodenum and held there with a double purse-string suture of silk, tied tightly enough to be temporarily hermetic sutures, to be finally cast off with the

catheter. Every justifiable effort, however, should be made to find the distal end of common duct before resorting to the direct union of the proximal end to the duodenum, because of the potential danger of an ascending cholangeitis. One of this series, while absolutely free of jaundice, has from time to time chills, fever, malaise, lassitude and all the signs of a cholangeitis without bile in urine, skin, or sclera, and with normal stools. Returned home in five weeks. All symptoms disappeared. Tube passed per rectum thirty-three days after insertion. Seven other cases have since been so treated with satisfaction.

Two years later, the excellent experimental work of Sullivan demonstrated the possibility of successful reconstruction of the resected common ducts in animals, by the insertion and maintenance there within the lumen of the ducts of rubber tubes during the time necessary for epithelialization. These experiments resulted in the evolution of the T- or fish-tail tube, and Sullivan had successful cases to report in the human in 1912. At a clinic given for the American Society of Clinical Surgery at Heidelberg, Germany, by Prof. Wilms, in the summer of 1912, we were shown as a recent discovery by him how to utilize a rubber tube for the purpose of repairing common duct defects!

Following Sullivan's early recommendations, came many successful applications in practise, usually with some means for the removal of the tube when it had completed its work. The well-known T-tube, having demonstrated the possibility of repair, has (like the Murphy button) given place to other methods, and for these reasons:

1. That in the effort to remove it, the short end of the T has several times been torn off instead of pulling through the opening of the common duct, or,

2. Has so torn the duct as to reproduce the original stricture.

Tying a strong ligature to the tube within the duct, by which it may later be forcibly removed through the wound is open to same objection. Leaving a short tube permanently in place in the duct itself is to be condemned because of the ultimate deposit of bile with recurrence of symptoms, as in Case II of

this series. In this case, I thought I had passed the tube through into the duodenum far enough to insure its escape by the alimentary tract, but operation one and one-half years later revealed bile deposit on the tube and in duct.

If there be one thing more than another that I desire to emphasize in this contribution to duct repair, it is this: That by the

FIG. 4.—Shows another catheter passed down through common duct into duodenum. This was one of the cases anchored by a thread to the surface until epithelialization of missing portion of duct had had time to occur. Thread cut at the end of four and a half months; tube passed in five weeks. Patient well two years.

constant duodenal and jejunal "tug" upon a catheter inserted through the duct or side of the duodenum it will ultimately be drawn into the intestine and discharged per rectum. In the 8 cases I have had, the shortest time of discharge has been twenty-seven days; the longest sixty-three. Hence we have a method of getting rid of a tube without a secondary interference. When,

however, it has been deemed necessary to have it remain until the surgeon desires its removal, this has been readily accomplished by tying to the catheter a simple waxed silk ligature, which, brought out through the interval between the ends of the duct being repaired, is carried through a very small rubber tube reaching from the duct to the surface of the body and fastened to an adhesive strip, the small tube covering the thread for its protective effect against cutting of tissues by the thread. When ready to cast off, the anchorage thread is cut at the surface of the skin. Within three to seven weeks, the catheter passes off through the alimentary tract, and the cure is completed.

This brings us to the question of how much of a gap between the distal and proximal ends can be thus repaired? Since by means of the anchoring thread we have a means of controlling the escape of the tube, it is simply a matter of judgment as to how long it will take the epithelium to grow between the two ends. No experiments of this nature are available; but in Case IV, where one-half to three-quarters of an inch had been excised, the thread was cut in four and one-half months, the catheter passing in five weeks, and the patient now well two years.

CASE REPORTS

CASE I.—G. L., a man of forty-eight (?), who, while seeking operation for a simple right inguinal hernia at a neighboring Clinic, awoke to find that an appendectomy and the removal of a stone from the gall-bladder added to his herniotomy had been done. With a biliary fistula persisting for a year, he returned to the Clinic, when a cholecystectomy was done, with prompt recurrence of the biliary fistula. After another year's interval of alternate opening and closure, followed by jaundice and fever, he returned for the third time to the Clinic for search for the source of common duct obstruction. During this third interference, so severe a hemorrhage occurred as to make it necessary to desist, leaving the hemostatic forceps *in situ* and packing the

wound, returning the patient to bed to recover from loss of blood, shock and so forth. The patient recovered and the wound healed (with the fistula persisting) and he returned home. While the fistula was draining, the patient was comfortable; when closed for three or four days, there was recurrence of jaundice, chills, fever, and common duct symptoms. After a lapse of several months the patient was brought to the writer.

October 1, 1907. On this date, and with the above history, an exploratory operation was made, following with great difficulty the course of the fistulous tract through a mass of adhesions of the stomach, liver, colon and duodenum to its source in a small remnant of the cystic duct, big enough to admit the index finger-tip, and containing mucopurulent bile with black biliary grit. Splitting open this pouch and its communication with the common duct, the latter was found dilated above this point sufficiently to permit palpation of right and left hepatic branches; below this point an average sized probe could be passed down into the duodenum. Two stones could be felt and they were removed from the dilated common duct, mixed with mucopus and grit. With the probe down the common duct, palpation revealed the duct, surrounded by much indurated cicatricial tissue; but, as the duct was patulous to probe and fluids, no effort was made to remove the narrowed portion or to divide the same. A No. 6 soft rubber catheter was passed down into the duodenum and the wound was closed after excision of the remnants of the cystic duct.

Recovery was uneventful. The catheter was utilized while *in situ* to flush out the circulatory system and kidneys by introduction of two or three liters of sterile water daily into the duodenum, this clearing up the jaundice rapidly.

The patient returned home in seven weeks with the wound closed. On March 19, he writes as follows: "December, 1907, first week: Wound reopened for several days. December 21: Chills, fever, general aching; wound reopened. December 23: Wound closed and has not reopened to March 19, 1908. No soreness or tenderness at site of incision; stools of good color up

to time of attacks, then still yellow, but lighter; no colic at any time; no pains in shoulder or side; there is some jaundice and itching."

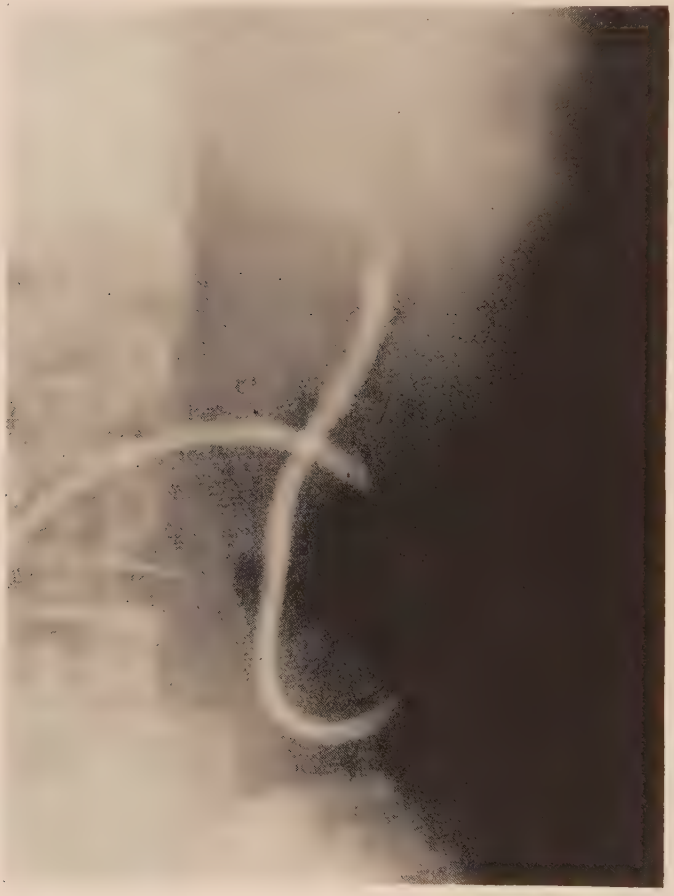

FIG. 5.—Shows catheter in duct and duodenum, held in place by anchor suture to surface of the body eight weeks, at which time thread was cut.

Between April and August, 1908, occasional repetitions of these obstructive symptoms, with septic reactions, led to the reopening of the wound on August 29, 1908, and the finding of

a stricture below the formerly opened area, the common duct being this time opened nearer the duodenal junction. The probe passes easily into the duodenum. When trying to probe upward, stricture found that admits only the smallest size probe. Divulsion of stricture and excision of scar-tissue sufficient to admit No. 16 English sound. On splitting open the stricture, several small black biliary calculi are discharged with free flow of bile. Insertion upward into dilated duct of rubber tube with double reverse cuff; fastening same there with chromic gut, then passage of other end well down the duct into the duodenum so that six to seven inches are free in duodenal lumen. Wound closed with cigarette drain to junction of duct ends.

Healing uneventful; no bile escapes through wound; patient returns home in five weeks; all symptoms disappear.

November 1, 1908. Patient writes: "Tube passed this morning; sixty-three days since its insertion. Am better than I have been for three years."

November 21, 1909. Reports self better than for four years, after extended trip through West. Has none of the old symptoms.

The patient died some years later from a stomach carcinoma.

Case II.—Mrs. B., entered St. Luke's Hospital, November 1, 1918, for obstruction of the common duct, with jaundice. Reopened the abdomen through old incision for cholecystectomy. No stones palpable in common duct. Pus, blood, albumen, casts (hyaline and granular) in urine. Quick insertion of two tubes at point of probable ligation of former cystic duct where stricture was found and split. One tube was inserted toward the liver in proximal end, and one downward toward the duodenum, and the wound hurriedly closed, the aim being to relieve cholemia by the simplest procedure. Recovery was good, but there was some intermittent jaundice; itching was gone at the end of the week. One month later still she was somewhat jaundiced.

Second Operation, December 23, 1918. Fistulous tract injected with methylene blue, and tract followed through adhesions to

the common duct. Opening in it was enlarged sufficiently to insert a $\frac{3}{8}$-inch rubber tube into the duct. On the upper end, a cuff or reverse had been turned back in order to enlarge its caliber and retard its escape into the duodenum. The tube was

FIG. 6.—Lateral view of Case VI, showing unusual course of duodenum.

about 4 inches long. The common duct was sutured over the tube at the slit in the stricture. The wound closed with drainage. Wound closed on the eleventh day. Stools became dark and urine light. Discharged nineteenth day (January 11, 1919).

Case III.—Mrs. S., May 28, 1918. Typical history of biliary colics, nausea, vomiting, and jaundice. Gall-bladder was drained seven years before, after removal of stones by Dr. G. Reoperation revealed an hour-glass stricture of the gall-bladder. Compartment at fundus filled with stones below stricture (probable former purse-string site). The gall-bladder was thickened

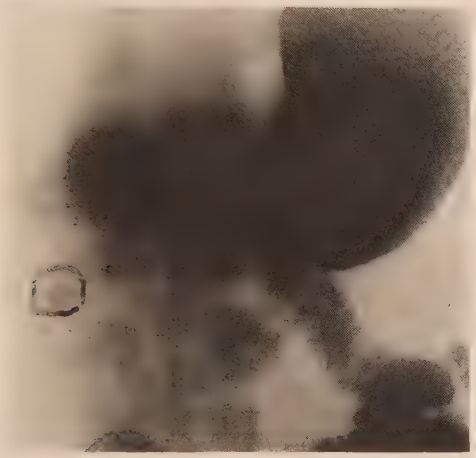

Fig. 7.—Illustrates a new aid to diagnosis of nature of obstruction in common duct. If the patient be studied fluoroscopically, by lateral view, during the passage of barium through the duodenum, it is many times possible for the roentgenologist, by massaging the duodenum, to make the barium enter the lower end of the common duct; if stone be present, to so coat the stone with barium that it will then show for many days in an *x*-ray picture. A stone endeavoring to escape from the common duct is probably preceded by a relaxation of the distal end of the duct similar to the softening and relaxation that occurs in the uterine cervix with the descending head of child. [I would ask the members in their future cases of suspected common duct stone obstruction, to test out this observation, as I believe they will have frequent gratifying confirmation of their suspicions.] Emphasis must be laid upon the need of lateral observation of the patient, because the common duct enters into the duodenum posteriorly and such a condition could not be seen through the full duodenum.

and infiltrated. The cystic duct was ligated with artery and vein, and cholecystectomy made. The drain was inserted down

to the stump. There was free flow of bile on second day. The wound healed, and the patient was discharged July 23, 1918.

December 1. The patient was sent to the hospital with a chill and fever. Leukocytes, 15,400. Pulse, 100. Temperature, 102.4. Urine highly colored. Stools light colored. The temperature was normal on the fourth day and the patient was discharged on December 7, 1918.

February 11, 1919. The patient returns to the hospital with jaundice, nausea and vomiting; pruritus.

Operation. The abdomen was opened through the old scar. The common duct was identified and opened. The probe passed downward easily into duodenum without obstruction; passed upward to meet the obstruction near the hilus of the liver. The duct was split upward along the probe to the obstruction, due to connective tissue constriction and scar-tissue. A portion of a small No. 7 soft rubber catheter was inserted with funnel, and was inserted above the constriction, and the other end was passed down into duodenum and duct closed over catheter, and a Bullitt drain inserted to the field of the suture. Drain was removed on the seventh day, February 18. Stools normal on the second day. The patient returned home, healed, on March 3, 1919.

After one and three-quarter years of comparative comfort, the patient again showed jaundice. On December 14, 1920, the abdomen required reopening. The common duct was reached through the adhesions without seeing free peritoneum. Opening the same, revealed a black silk suture as the nucleus of a gall stone at site of former stricture. It was deemed advisable to suture the proximal end of the common duct to a new opening in the side of the duodenum. This was done by inserting a purse-string suture in the duodenal wall, passing nearly the whole catheter down the duodenum through the small button-hole incision and tightening the purse-string suture. The funnel end was inserted in the proximal end of the common duct above the stricture, and the common duct end was sutured to the duodenum by four fine silk sutures. A drain was inserted

to the bottom of the wound and removed on the seventh day. The patient was discharged on December 30. Tube passed the twenty-seventh day.

CASE IV.—Mrs. M., December 30, 1912, aged twenty-nine years, married. The patient was operated on ten months ago for gall-bladder disease; then again six weeks later. For four months there were intermittent jaundice, pain and vomiting, and the stools were clay-colored. Stricture of the common duct was found and opened. A tube was inserted with the cuff turned back for the proximal end; the other end was carried down into the duodenum; the duct was sutured over it; the wound was closed with drainage. Recovery was prompt, with relief of symptoms. The tube passed in nine weeks.

CASE V.—Patient aged thirty years, married, two children. There was frank gall-stone disease, associated with occasional jaundice. No previous operations.

Operation. (June 9, 1921, at St. Luke's Hospital.) The simplest type of cholecystectomy was done, following the best-known technic of subperitoneal resection of the cystic duct after satisfactory isolation and identification of both artery and duct. I never did a more comfortable, easy cholecystectomy. There were many stones. After the wound was closed and the patient was in bed, inspection of the specimen showed a peculiar $\frac{1}{4}$-inch tubular structure attached to one side of the cystic duct portion of the gall-bladder. Immediate frozen section showed it to be lined with epithelium similar to the duct. I immediately realized my mistake, told the family physician, (who had watched and complimented the careful operation) and the relatives frankly what had happened and explained the necessity of immediate opening of the wound to resuture the duct. This was done. The ends of the duct were picked up and the catheter was passed down almost entirely into the duodenum through the distal portion. Inasmuch as there had never been any dilatation of the common duct, it was not feasible to insert upward the

funnel end of the catheter, so the funnel was amputated and the cut end passed up to the liver. In order to anchor it in place, a medium-sized wax silk ligature was tied to the catheter at the area uncovered by the duct and anchored to the surface of the skin by adhesive plaster; then the ends of the ducts were approximated toward one another to within half an inch. The wound was sutured. Some bile discharged until the anchor thread was cut four and a half months after operation—September 14. The catheter passed November 7, 1921. The wound ceased leaking in ten days after the thread was cut. The patient was then apparently perfectly well. See *x*-ray chart of catheter *in situ*.

Case VI.—O. E. C., aged sixty-seven years. white, married, male. Onset two weeks ago. Weakness, anorexia, heaviness in stomach, nausea, emesis. Jaundice began two days later and grown steadily deeper, with clay-colored stools. Past history negative. Entered hospital, February 17, 1923. Temperature ranging up to 101.6; pulse 100; respiration 24. Blood count: Reds, 4,450,000. White, 18,400. Hemoglobin, 95 per cent. Urine, loaded with bile, otherwise negative. Stools acholic. Physical examination: General abdominal rigidity.

Operated (February 19, 1923). Massive adhesion about gall-bladder, which was found to be very small, thickened, filled with small stones and mucopurulent material and no bile. Lining ulcerated. Gall-bladder removed. Cystic end ligated. Common duct greatly distended to such a size that it was at first mistaken for duodenum. A large stone found wedged in ampulla of Vater—removed through slit in common duct. A small No. 14 Fr. catheter was fed downward through this slit into duodenum, all but last 2 inches which was fed upward with its bell-mouth toward the liver in the common duct. A heavy silk anchor line tied to catheter at point opposite slit in common duct was carried out and fixed to skin by adhesive. Slit completely sutured around anchor line. Abdomen closed with accessory Bullitt drain for two days.

Patient made uneventful recovery; jaundice rapidly disappeared; never any discharge of bile on dressings. *X*-ray picture of March 15, 1923 (Fig. No. 6) shows catheter still in place. Anchor line cut March 15. Patient last heard from June 1: Feels entirely well and is attending to business; is not sure whether he has passed catheter or not. Advised to have *x*-ray picture taken to prove this.

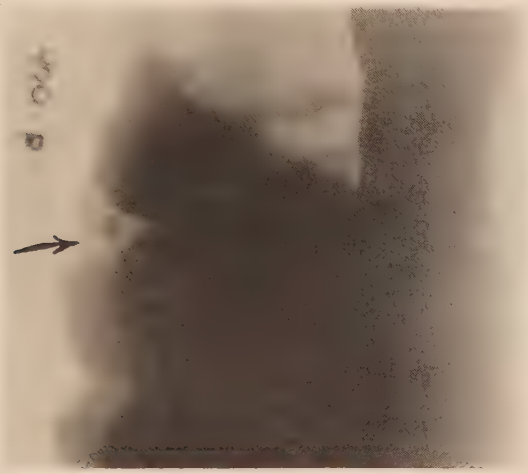

FIG. 8.—Similar case to Fig. 7, in which a roentgenologist was able to manipulate the duodenum in such a way as to drive some barium mixture into the common duct, coat the stone lying there, and make it visible, as seen in the picture.

CASE VII.—J. L., aged fifty years, male, white, married. Present complaint: Intermittent jaundice, alternating with intermittent biliary fistula, following an operation done elsewhere one year ago for relief of typical gall stone history of three years duration. History otherwise negative. Entered St. Luke's Hospital, February 5, 1923. Examination shows small discharging biliary fistula in an otherwise healed right rectus scar. Blood and urine normal. Stool negative. A diagnosis was made of common duct stone from history and especially from an *x*-ray picture taken during the course of a

barium gastrointestinal examination, which left stone plainly coated with the barium (see Fig. No. 7), which had regurgitated into ampulla and remained behind when the duodenum had emptied itself.

Operation (February 7, 1923). Fistula traced down through adhesions to remains of a badly diseased gall-bladder, which was removed. A large stone easily palpable in the ampulla of Vater could not be milked back into the common duct. A trans-duodenal choledochotomy allowed removal of stone. Then a fine catheter was fed through stump of cystic duct, through the common duct into the duodenum; the other end of catheter brought out to the skin. Fenestra had first been cut in side of catheter in that portion contained in common duct. The hole in the duodenum was then completely closed with a double row of silk stitches. Abdomen closed with accessory Bullitt drain. Patient made uneventful convalescence. Catheter removed at the end of a week. Patient last seen June 4; feels fine; has gained twenty-five pounds; back at work.

AN OPERATION FOR THE RELIEF OF CARDIOSPASM ASSOCIATED WITH DILATATION AND TORTUOSITY OF THE ESOPHAGUS

By LEONARD FREEMAN, M.D.
DENVER, COLO.

About twenty years ago a man, aged thirty-four years, came under my care for a severe cardiospasm which had seriously annoyed him for ten years. Although there had been intervals when he could swallow reasonably well, nevertheless the trouble had steadily increased until he could not be sure of swallowing anything but liquids, and these only with great and prolonged effort. He had become so extremely weak and emaciated that he could accomplish no sort of labor, and it was with the greatest difficulty only that he could get about at all. Profuse salivation, especially at night, and frequent, copious emesis, from the dilated esophagus, were among the annoying symptoms.

There were no evidences of cancer or other form of tumor in connection with the esophagus; neither was there a history of syphilis, typhoid, diphtheria or injury by any corrosive substance, or anything else that might have caused the formation of a stricture. In addition to this a large gastric tube could at all times be passed into the stomach without much difficulty.

The character of the symptoms, together with the permeability of the canal and the length of time during which the lesion had persisted, pointed either to a cardiospasm with much dilatation or to a large low-lying diverticulum. The *x*-ray at that time not being available for more accurate diagnosis, an exploratory operation was decided upon.

Operation (July 14, 1902). The esophagus was easily uncovered through the usual vertical incision on the left side of the base of the neck. No diverticulum was found, but, beginning just above the cricoid and extending farther down behind the sternum than the finger could reach, the esophagus was uniformly dilated into a great, slack, thin-walled, sac-like tube, around which the examining finger easily could be swept within the mediastinum.

Still searching for a possible diverticulum, which did not exist, I pulled upward on the dilated tube until a large fold, including the entire circumference, protruded through the incision in the neck, and the portion below was rendered quite taut. There was no difficulty in accomplishing this, owing to the surprisingly loose manner in which the esophagus seemed to hang within the mediastinum.

Having arrived at this point, with the loop of esophagus lying exposed upon the neck, I was embarrassed as to what to do next. I did not want to resect the loop because of the danger of infection, and yet the situation called for action of some sort. Finally, it was decided to invaginate the upper segment of the loop into the lower without opening its lumen, thus restoring to the tube something of its proper length and longitudinal tension. This intussusception, maintained by means of a few stitches of chromic gut, formed such a bunch in the esophagus that I feared its complete occlusion, so a stomach tube was passed and left in place for a few days, although I now question the necessity of such a procedure.

The wound was closed and healed by primary union. The patient soon recovered his full ability to swallow and in a few weeks had regained his strength and energy. Up to the present time (twenty years) he has had no return of his trouble except an occasional slight dysphagia. He has been able to live his life and do his work with ease and comfort.

The outcome of this case perplexed me much. It seemed evident that the operation had brought about a cure, but I did not understand how. If the trouble always was due to a

spasm of the cardiac muscle, as believed at that time, why should it be cured by a mere invagination of the dilated esophagus higher up? Finally I connected it up vaguely with the shortening and narrowing of the esophagus and let it go at that. I did not report the occurrence because I did not clearly understand it.

Recently I came across an article by Herman Kümmell[1] which throws light upon the subject and has given me a new interest in it. Among other things he emphasizes the tendency to failure of the current forms of treatment, such as the various methods of dilatation from above and from below, the division of the sphincter muscle, etc. But my attention was attracted particularly to a paragraph dealing with the pathology of the affection, in which it is stated that the difficulty in swallowing may be due to either of two conditions or to their combination. One of these is cardiospasm, followed more or less closely by dilatation, and the other is where the esophagus is not only dilated but also convoluted, as though it were much too long for the mediastinum. This latter form, often of congenital origin, may or may not be preceded or accompanied by spasm of the cardiac muscle, the difficulty in swallowing being due more to the peculiarities of the dilated and convoluted tube than to the muscular spasm of its outlet.

Kümmell then recounts a case of the second variety in which, after the failure of other treatments, he attempted to obtain a cure by opening the abdomen, loosening the cardia from its diaphragmatic connection, pulling down the redundant esophagus, dividing it at the stomach and anastomosing it with the jejunum. The stomach itself he shifted upward to the neck, through a subcutaneous tunnel over the sternum, with the intention of ultimately uniting it to the cervical esophagus. But for some reason this highly ingenious and complicated procedure failed to produce a permanent result, although the patient was fortunate enough to survive. A number of sim-

[1] Arch. klin. Chir., cxvii, 193.

ilar operations also have been done, with more or less success, by various other surgeons (Sencert, Oettinger, Caballero, Sauerbruch, Exner, Tuffier, etc.), having the common objective of straightening out the esophagus by pulling its redundant portion down into the abdominal cavity and perhaps anastomosing it to the stomach or to the duodenum. Reisinger plicated the esophagus, with an indifferent result, through an opening into the posterior mediastinum, the operation being done in two stages owing to the collapse of the patient. Willy Meyer[1] describes two longitudinal plications done by the transpleural route, the results being rather unsatisfactory. More recently, Pribam[2] says: "It might also be considered if one could not, after exposure and mobilization of the esophagus in the neck, pull it upward and thus do away with its tortuosity. A resection of the esophagus in the neck would be accompanied by but little danger [!]." He adds, however, that this had not yet been tried.

If the assertion of Kümmell is true that the dysphagia in some instances is due more to undue length and tortuosity of the gullet than to spasm of the cardia, the satisfactory result obtained in my own case by telescoping the esophagus into itself is easily understood. By means of this procedure, not only was the length of the tube lessened and its tortuosity removed, but at least a portion of its caliber was considerably diminished, thus increasing the muscular tone and doing away with obstruction arising from the slack folds. At any rate the effect was good and permanent. The operation also has the advantage of simplicity and safety, the danger of infection practically being absent, because it is unnecessary to open the esophagus. To be sure, one case does not prove much, but I venture to report it in the hope that further experience with the method may show it to be of value under appropriate circumstances.

[1] Int. Jour. Surg., 1912.
[2] Arch. klin. Chir., 1922, cxx, 207-

DISCUSSION

Dr. Miles F. Porter, Fort Wayne:

I believe that Dr. Freeman will find the explanation for the therapeutic result, in part at least, in the fact that his operation duplicates very closely Nature's physiological way of dilating sphincters for the passage of bulky material. Thus in emptying the rectum, for instance, the tube is shortened before the sphincter dilates.

Dr. Howard Lilienthal, New York:

Dr. Freeman has devised an original and most valuable method for dealing with cases of this kind. I believe that it should be the method of choice before making an exposure through the thorax or abdomen. Dr. Freeman's case may not have been a true cardiospasm: It was probably one of those described by Chevalier Jackson as hiatal esophagismus, due to the persistent tonic contraction of the diaphragm at the hiatus. Jackson speaks of the pinch-cock action of the diaphragm in describing the contraction of this muscle upon the esophagus. A congenitally gigantic esophagus, lying in folds, may account for the failure of food to pass normally into the stomach.

Dr. Willy Meyer, New York:

In the cases of so-called intractable cardiospasm I have operated on I have laid stress on the possibility of the cardia tonus being due to the pneumogastrics. By means of transpleural thoracotomy the esophagus was exposed, both nerves separated from the dilated pouch by clipping the short branches and double plication added. In both cases the patients regained the power of swallowing, though other complications later on marred the immediate result.

Dr. Freeman's case certainly is most instructive. It seems that here reduction of the size of the supracardiac dilatation by stretching alone, without vagolysis, brought on the favorable results.

At one of the first meetings of the American Association for Thoracic Surgery I heard Dr. Plummer state that in almost every case of cardiospasm he succeeded in passing a string and later on stretching the cardia with the help of his ingenious method and thus curing the patients.

It seems, therefore, that in treating such conditions stretching of the sphincter should be the first method to be resorted to. Should this fail or be impossible, operative procedures come into consideration.

Dr. F. N. G. Starr, Toronto:

Is it not possible that the spasm occurs in the diaphragm, and that, therefore, in drawing up the esophagus it interfered to some extent with the nerve supply to the diaphragm? It seems to me that the mere drawing up may be responsible for the spasm. I believe that somebody has referred to this recently in the literature on the subject, and suggested, as a means of cure, exposure of the phrenic nerve in the neck on the side affected and then freezing it with ethyl chloride.

Dr. Freeman (in closing):

With regard to pictures of my case, I regret to say that it occurred before the *x*-rays were in common use, and so, unfortunately, I do not have any pictures.

The particular method that I used applies to a definite type of case only, in which the difficulty has gone beyond the stage of cardiospasm, if it ever depended upon cardiospasm at all.

CARDIOPLASTY FOR CARDIOSPASM

By STEPHEN H. WATTS, M.D.
CHARLOTTESVILLE, VA.

The etiology, diagnosis and non-operative treatment of cardiospasm have been thoroughly discussed in recent years by Plummer, Smithies and many others, but comparatively little has been written regarding the operative treatment of the condition. This is quite natural considering that very few of the cases require surgery for their relief; in fact, it is possible that surgery is justifiable only where the hydrostatic dilator cannot be passed through the cardia with the aid of a silk-thread guide, as in my case, but experience at the Mayo Clinic shows that this must be extremely rare. Vinson has reported a case with very marked dilatation and angulation of the esophagus in which he was able to pass the dilator on a flexible bougie.

Since a radical operation at the cardia is a rather formidable procedure, it might be advisable, in the rare cases in which a silk thread cannot be gotten into the stomach by way of the mouth, to open the stomach, stretch the cardia and pass a strong thread backward through the esophagus, bringing the lower end of the thread out through a gastrostomy and leaving it as a guide for the hydrostatic dilator to be passed by the mouth.

The cases with great dilatation and atony of the esophagus might seem to indicate surgery, but it is said by Plummer and Vinson that these respond particularly well to hydrostatic dilatation. However, in my case, in spite of a large opening

at the site of the cardioplasty, the esophagus is still quite dilated more than a year after operation, but the symptoms are perfectly relieved.

J. C. Russel, in 1898, first dilated the cardia by means of a rubber bag covered with silk. This method has been perfected by Plummer and others and has become the standard method of treating cardiospasm.

Gastrostomy alone in this condition is only a palliative measure. The first operation for the relief of the cardiospasm was published in 1904 by Mikulicz, who opened the stomach and thoroughly stretched the cardia by means of a rubber-shod clamp introduced into it under guidance of the finger. He reported 6 cases treated in this manner, with good results in 5. The poor result in the other case was attributed to scar formation due to suppuration. Most of the operators who have used this method have reported only single cases, and, as a rule, have substituted their fingers for the instrument in stretching the cardia. Schloffer, in 2 cases, very gradually dilated until five fingers were passed into the cardia. In spite of this thorough stretching there was a tendency to recurrence. After some months there were few or no clinical symptoms, but the *x*-ray showed some delay in the esophagus.

Pamperl, in 1919, collected 14 cases operated upon by the Mikulicz method, of which 12 were said to be cured and 2 improved. In addition to these, he reported the 2 cases of Schloffer mentioned above. Thieding, in 1921, collected 3 more cases successfully treated by this method. The operation was somewhat modified by Kümmell, who suggested that the stretching be done without opening the stomach by invaginating the stomach wall on the fingers. This has been tried twice with little or no success. In one of these cases Schmielensky was unable to dilate the cardia in this way; therefore, he opened the stomach and stretched the cardia with forceps. The esophagus was torn and the patient died. This seems to be the only case on record in which death was caused by the Mikulicz operation.

In 1907, Reisinger reported a case of enormously dilated esophagus with cardiospasm in which he exposed the esophagus in the posterior mediastinum by rib resection with the idea of plicating the esophagus. This was prevented by collapse of the patient. Several weeks later a strip of the esophageal wall, 15 cm. long by 2 to 3 cm. wide, was excised and the esophagus sutured. On account of the breaking down of the suture many operations were required to secure permanent healing after many weeks. The condition of the patient was said to be finally greatly improved by the operation.

The operation of esophageal plication devised by Reisinger was later done by Willy Meyer transpleurally under differential pressure. The vagi were separated from the esophagus and the latter plicated. He reported 3 cases. One case was greatly improved for a while, in fact it was considered cured, but later developed an esophageal fistula and died about a year after operation of posterior mediastinitis. In the second case there was some improvement in swallowing immediately after the operation, but the former difficulty gradually returned. In the third case there was no improvement.

Plication of the esophagus would not seem to offer much hope of success in these cases, as it does not remove the cause of the trouble.

In 1910, Wendel reported the first cardioplasty for cardiospasm. After turning up the costal margin he exposed the cardia, which was narrowed to the size of a lead-pencil over an extent of 4 cm. A vertical incision was made through the anterior wall of the cardia and sutured transversely. The patient was cured. My case seems to be the only other one in which this type of operation is reported, and in my case the operation was more after the order of the Finney pyloroplasty. Willy Meyer has done a transpleural cardioplasty four times in dogs, with recovery in each instance, and suggests that this may be the proper procedure in certain cases of cardiospasm.

In 1914, Heller described an extramucous cardioplasty and reported a case of chronic cardiospasm with dilatation of the

esophagus treated in this manner. After turning up a flap of costal margin the esophagus was freed by division of the peritoneum at the hiatus esophageus and by blunt dissection. It was drawn down and the musculature on the anterior and posterior aspects of the cardia was divided down to the submucosa over an extent of 8 cm. The day after operation the patient could swallow any kind of nourishment without difficulty.

At the German Surgical Congress, in 1921, Heller reported that this case was in good condition and free from symptoms seven years after operation, but the *x*-ray showed a constant narrowing at the cardia, of which there was no evidence just after the operation. He stated that he knew of 16 cases which had been operated upon in this way by various operators. There were no fatalities. The results were good in 12 cases and poor in 4. One case of Zaaijer developed a cicatricial contraction of the cardia which required an esophagogastrostomy. Heller says that division of the musculature is not difficult, but that the operation should not be done in early cases without marked dilatation of the lower esophagus.

Herovsky, in 1913, reported a case operated upon in the following manner: After turning up the costal margin the esophagus was loosened at the hiatus and anastomosed to the fundus of the stomach by suture. The patient was completely relieved. Later, esophagogastrostomy for cardiospasm was done by Exner, Enderlin, Finsterer, Sauerbruch and a few others with rather satisfactory results. Of the 3 cases thus treated in Sauerbruch's Clinic, 1 died and the other 2 were greatly benefited. In 1914, Röepke, after making a costal flap, mobilized the esophagus at the hiatus esophagus, drew it down about 10 cm. into the abdomen, removed the peri-esophageal tissue down to the musculature by blunt dissection and then incised the anterior edge of the hiatus. After this operation any kind of food could be taken. Borchgrevink reports a case in which this operation was followed by sounding with perforation and death.

Resection of the cardia for cardiospasm as proposed by Rumpel, in 1897, has apparently not yet been done.

From this review it would seem that the simplest operative measure is stretching the cardia by way of the stomach, but this may be followed by a recurrence. The extramucous cardioplasty of Heller is probably the simplest and best radical operation, if it is as easy and efficient as the reports would lead us to believe. A cardioplasty resembling the Finney pyloroplasty, as done in my case, would probably not be difficult in cases where the dilated esophagus bulges through the hiatus, provided the costal margin is turned up to secure a better exposure, but the possibility of infection here presents an element of danger.

Case Report.—Mrs. M. D., white, aged thirty-nine years, was first admitted to the University of Virginia Hospital, August 27, 1919, complaining of shortness of breath and regurgitation of food.

Family History. Unimportant.

Previous History. Unimportant.

Present Illness. About fifteen years ago the patient began to feel as if there were a lump in her throat after eating, as though the food had lodged behind the lower end of the sternum. Soon after this she began to regurgitate her food. The condition gradually grew worse, with increasing difficulty in getting food into the stomach. At the present time she eats about one-half of her meal, then drinks about a quart of water, finishes the meal and drinks more water.

The regurgitated food comes back just as it was eaten; milk comes back thick but not sour. Most of the food comes back in from five to fifteen minutes after eating, but some of it comes back at irregular intervals until the next meal. Often a part of her supper comes back the next morning just as it was eaten the night before.

The patient at this time was fairly well nourished. The *x*-ray photograph, after giving one quart of opaque meal, showed an enormous dilatation of the esophagus, tapering down to a sharp point at the cardia and none of the barium was in the stomach (Fig. 1). She left the hospital without treatment,

promising to return in two weeks for dilatation. However, she did not come back for a year, *i. e.*, September 13, 1920. She had lost considerable weight and she had still more difficulty in getting food into the stomach; in fact, she often found it

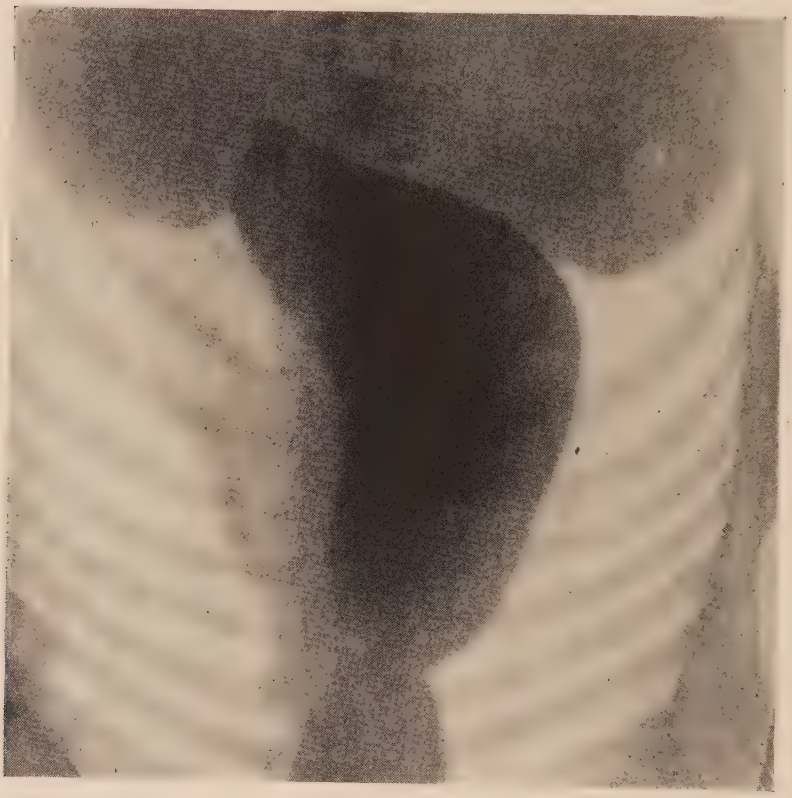

FIG. 1.—August 30, 1919. Enormous dilatation of esophagus.

necessary to make pressure in the suprasternal notch, where there was a distinct fulness. The *x*-ray examination gave the same picture as described above. Numerous attempts to pass bougies and to have her swallow a thread were unsuccessful, so she was transferred to the surgical service.

Operation (September 24, 1920). *Gastrotomy; Digital Stretching of Cardia; Gastrostomy.* Incision was made through the upper portion of the left rectus muscle. The stomach was somewhat contracted, but nothing like so much as had been

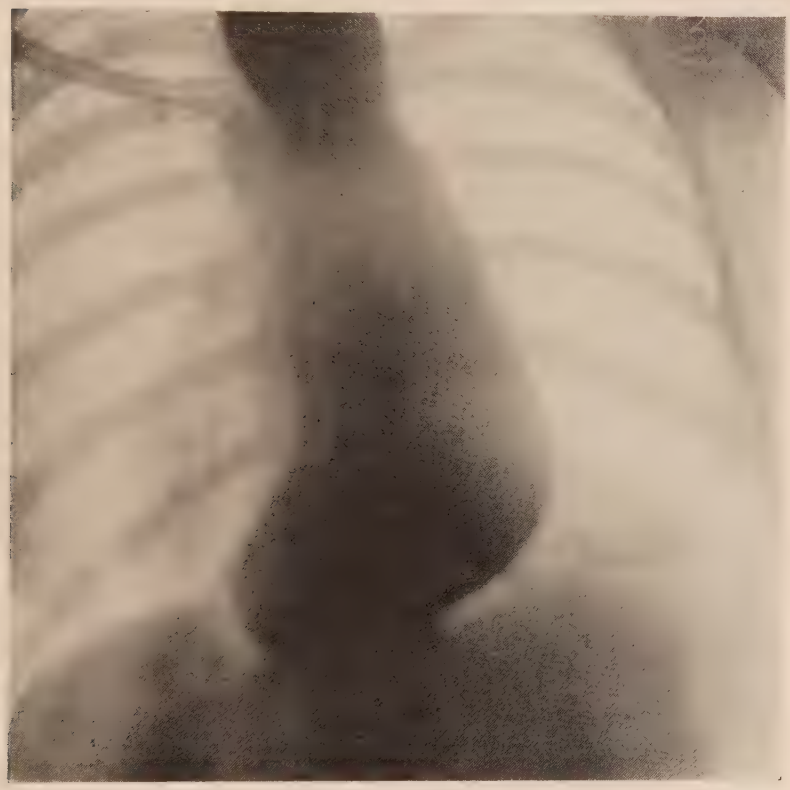

FIG. 2.—October 13, 1920. Practically no change. Very small stream of opaque meal passing into stomach.

expected. Examination of the cardia showed it to be quite narrow, apparently in spasm, but an interesting point was that about 4 cm. of the dilated esophagus could be seen below the diaphragm. A cardioplasty was considered, but was given up on account of the rather inaccessible location of the cardia.

The stomach was opened near the cardia and two fingers were easily passed through the cardia, which was stretched by separating the fingers. This opening in the stomach was closed and a Frank gastrostomy was done, with the idea of thus feeding

FIG. 3.—April 2, 1922. Three weeks after cardioplasty. Immediately after giving opaque meal. Considerable amount of meal in stomach.

the patient and allowing the greatly distended esophagus to contract.

The patient's condition was slightly but temporarily improved by this operation, perhaps due to insufficient stretching of the cardia. *X*-ray, October 13, 1920 (Fig. 2), showed only a very

small amount of the opaque meal passing into the stomach. She became dissatisfied, complained of pain caused by the gastrostomy tube, demanded its removal and left the hospital.

FIG. 4.—September 15, 1922. Six months after cardioplasty. Note marked shrinkage of esophagus, the large opening at the cardia and the well-filled stomach.

She came to the hospital again about a year later, November 9, 1921, complaining of inability to get food into the stomach, of sore mouth and sore, swollen hands. About three months before, when she was weighing 130 pounds, she became unable to force food into the stomach as she had formerly done; her mouth soon became sore and her hands and arms seemed

inflamed. Her hands became worse—swollen, dry and cracked. She developed a diarrhea, lost weight rapidly and became greatly depressed mentally.

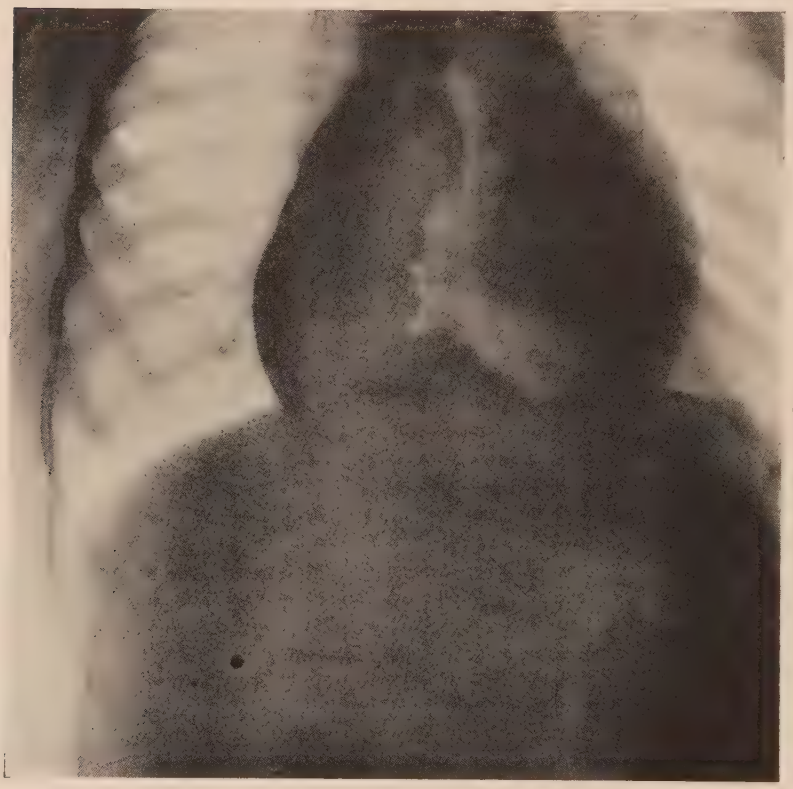

FIG. 5.—May 5, 1923. Practically no change since last picture.

Her weight on admission was 70 pounds. There was a glove-like area of dermatitis, involving the dorsum of the fingers, hands and forearms, extending to within three inches of the elbow. It was symmetrical on the two sides. The skin was thickened, rough, brownish, inelastic, scaly and fissured, and the edge of the involved area was sharply demarcated. There was moderately marked stomatitis, involving chiefly the tongue,

which was red, furrowed and swollen. There were all the cardinal symptoms—nervous, cutaneous, gastrointestinal and metabolic—of pellagra.

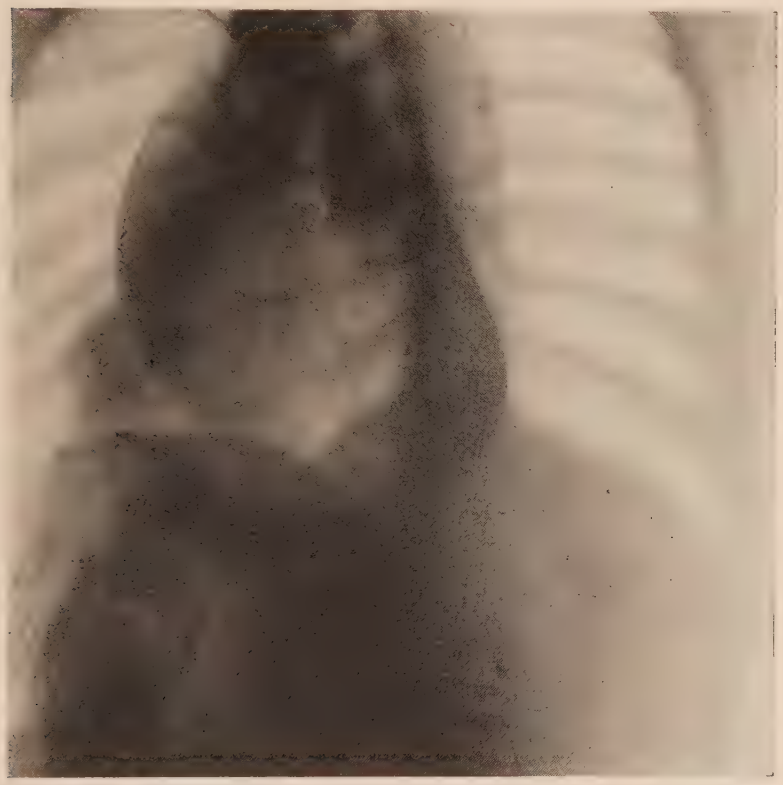

FIG. 6.—May 5, 1923. Small amount of opaque meal in lower esophagus one-half hour after meal.

The gastrostomy was reopened on November 15, 1921, and a tube reinserted. She was given a diet with a high protein and vitamine (especially water-soluble vitamine three) content. She improved rapidly and symptoms of pellagra gradually disappeared. In three months she had gained 60 pounds and weighed 130 pounds.

X-ray picture at this time was practically the same as on her first admission, and attempts to pass an esophageal dilator were again unsuccessful. At her urgent request a radical operation was undertaken.

Operation (March 13, 1922). *Cardioplasty for Cardiospasm.* Incision was made through the old scar and the stomach separated from the abdominal wall, an opening 4 cm. long being left in the stomach at the site of the gastrostomy. Numerous adhesions were encountered in the upper left abdomen, but with considerable difficulty these were separated and the cardia exposed. It seemed rather narrow and the bulging esophagus could be seen above it. An incision, 4 cm. in length, was made through the anterior aspect of the cardia, extending equally into the esophagus and stomach. These structures were approximated and sutured together with chromic gut very much after the manner of a Finney pyloroplasty. The old gastrostomy opening was closed and a new Frank gastrostomy made. A cigarette drain was inserted through a stab wound in the left flank and the abdomen closed.

She made an excellent recovery, in two weeks was able to take any kind of soft diet, and it was then unnecessary to use the gastrostomy. *X*-ray picture (Fig. 3), taken immediately after the giving of the opaque meal on April 2, 1922, three weeks after the operation, showed a considerable amount in the stomach.

She left the hospital, April 29, 1922, and since that time has had no trouble whatever referable to her esophagus, though she did enter the hospital about a month later with a definite appendix abscess which was absorbed without operation.

X-ray picture, September 15, 1922 (Fig. 4), showed marked shrinkage of the esophagus, a large opening at the cardia and a well-filled stomach. The patient was last seen on May 5, 1923, when she stated that she was perfectly well and could swallow any kind of food without difficulty. Her weight was 166 pounds. *X*-ray gave practically the same picture (Fig. 5) as in September, 1922, and we were somewhat disappointed that there had

apparently been little or no further shrinkage of the esophagus. The picture, one-half hour after the meal (Fig. 6), showed a small amount of the meal in the lower esophagus.

Bibliography

Erdman, J. F.: Cardiospasm, Ann. Surg., 1906, xliii, 224.

Exner: Beiträg zur subphrenischen Oesophagogastrostomie, Wien. klin. Wchnschr., 1917, 886.

Heller: Extramuköse Cardioplastik beim chronischen Cardiospasmus mit Dilatation des Oesophagus, Mittheil. a. d. Grenzgeb. d. Med. u. Chir., 1914, xxvii, 141.

Heller: Verhandl. d. deutsch. Gesellsch. f. Chir., 1921, xlv, 144.

Herovsky: Kasuistik und Therapie der idiopathischen Dilatation der Speiseröhre, Oesophagogastroanastomose, Arch. f. klin. Chir., 1913, c, 703.

Iden: Cardiospasm, Jour. Am. Med. Assn., 1911, lvi, 1438.

Kümmele: Zur Operation des Kardiospasmus und des Oesophaguscarcinoma, Arch. f. klin. Chir., 1921, cxvii, 193.

Meyer, W.: The Operative Treatment of Intractable Cardiospasm, Am. Jour. Surg., 1912, xxvi, 193.

Mikulicz: Zur Pathologie und Therapie d. Cardiospasmus, Deutsch. med. Wchnschr., 1904, xxx, 17.

Pamperl: Zur operativen Behandlung des Kardiospasmus, Deutsch. Ztschr. f. Chir., 1919, cxlviii, 206.

Plummer and Vinson: Cardiospasm: A Report of 301 Cases, Med. Clin. North America, 1921, v, 355.

Reisinger: Ueber die operative Behandlung der Erweiterung des Oesophagus, Verhandl. d. deutsch. Gesellsch. f. Chir., 1907, p. 86.

Röpke: Zur Operation des Oesophagospasmus, Verhandl. d. deutsch. Gesellsch. f. Chir., 1914, p. 121.

Russell, J. C.: Diagnosis and Treatment of Spasmodic Stricture of the Esophagus, British Med. Jour., 1898, i, 1450.

Smithies: Diagnosis and Clinical Manifestations of Cardiospasm Associated with Diffuse Dilatation of the Esophagus, Am. Jour. Med. Sci., 1921, clxii, 313.

Thieding: Ueber Cardiospasmus, Atonie und "idiopathische" Dilatation der Speiseröhre, Beitr. z. klin. Chir., 1921, cxxi, 237.

Vinson: A Case of Cardiospasm with Dilatation and Angulation of the Esophagus, Med. Clin. North America, 1919, iii, 623.

Wendel: Zur Chirurgie des Oesophagus, Arch. f. klin. Chir., 1910, xciii, 311.

THE OPERATIVE CURABILITY OF CARCINOMA OF THE STOMACH

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A LESION which comprises about one-third of all instances of carcinoma, and which hitherto has been so insusceptible of successful treatment that it has been generally regarded by the medical and lay public as nearly hopeless, certainly deserves the most earnest study in an endeavor to improve our results. Such a lesion is carcinoma of the stomach. While there is some variation in the reports from different clinics, it seems to be a conservative statement that, taking into consideration both its frequency and its obstinacy, it is the chief single contributor to the total cancer mortality.

There appears to be no inherent reason why carcinoma of the stomach should present such a problem. Its natural history is presumably similar to that of carcinoma elsewhere. Disregarding for a moment its etiology, we may say, in accordance with prevailing views, that its original focus is a cell or group of cells endowed with the fatal property of atypical and unregulated division and growth; that it increases at first by invasion of the tissues of the stomach itself or of neighboring and adherent organs, and that at some variable and not to be predicted time it further disseminates itself by cellular emboli in the lymph or venous blood streams. A fourth method of spread can only be possible in a hollow organ which lies free in a body cavity, namely, the breaking off of small cell masses from the parent growth and their implantation either at another point of the

mucous membrane within the stomach or at various points in the peritoneal cavity outside the organ. If these accepted views are correct, surgical removal of the focus while still localized will cure the disease.

Anatomical and physiological considerations offer every encouragement to the belief that extirpation is possible. The stomach is accessible to attack, and especially the part between the incisura and the pylorus, where, according to Welch's classical analysis of 1300 cases, about 70 per cent of the lesions occur. The first relay of nodes receiving the lymph stream from this region lie along the borders of the viscus, between the layers of the gastrohepatic and gastrocolic omenta respectively, and are thus susceptible of removal. The blood supply is very rich and there is a free intramural anastomosis between the lesser arterioles, so that the most extensive resection and elaborate restorative suturing can be carried out without fear of devitalizing what remains of the organ, a condition which contrasts sharply with the small intestine. The union of the proximal part of the stomach with the jejunum may be technically more or less difficult, depending on the extent of the resection, the adiposity of the patient and other factors, but it may usually be accomplished satisfactorily. The loss of the function of the stomach furnishes no insuperable obstacle to operation. Here, as in so many other instances, Nature has been lavish in bestowing an excess margin of physiological efficiency, so that a large part, or even the whole of the stomach, may be sacrificed without seriously affecting the digestive function. Subtotal gastrectomy is commonly performed, and there are enough instances of the maintenance of health after a practically complete removal of the organ to justify the surgeon in being as radical as is made necessary by the extent of the lesion. The well-recognized rule that when one member of a physiologically related group of organs gradually becomes crippled by disease, the other members may assume compensatory increase of efficiency is applicable here, for in some slowly developing forms of carcinoma, such as the scirrhous or "leather bottle"

type, the stomach may be reduced to a mere tubular canal along which the food passes rapidly through a gaping pylorus, without the delay necessary for the exercise of the chemical or motor functions of the organ, which indeed have been destroyed by the disease. Such a patient may maintain a surprising degree of health, and the successful removal of the greater part of such a stomach may not affect seriously the digestive processes.

If these facts are admitted, why have the results of radical operation been so generally unsatisfactory? Perhaps it is because the disease is disseminated from the original focus at an earlier period than is the case with carcinoma in other situations. But the opinion that the disease may remain local for a long time seems to be justified by review of the history of certain cases which have come to operation or autopsy, and other cases where exceptional circumstances have given opportunity to follow the natural history of the disease. Two forms of dissemination will admittedly render a case incurable—that is, implantations in the peritoneal cavity in cases where the disease has penetrated the visceral wall and metastases to the liver by way of the portal blood stream. The first form can necessarily occur only in the comparatively late stages of the disease. Table I shows the incidence of metastases to the liver in cases occurring at the Peter Bent Brigham Hospital.

TABLE I.—INCIDENCE OF METASTASES TO THE LIVER

Among 67 operative cases in which the condition of the liver could be observed there were:

	Number of cases.	Per cent.
Metastases present	15	22.3
Metastases absent	52	77.7

Among 22 non-operative cases coming to autopsy the liver showed:

Metastases present	17	77.2
Metastases absent	5	22.8

Inasmuch as among the 67 operative cases in this table in only 23 could a radical operation be performed, in 29 (43.2 per cent)

the obstacle to such an attempt was not metastases in the liver but rather the local extent of the disease or of its lymphatic dissemination. It is striking to note also that in cases which have died of carcinoma of the stomach the liver was still not involved in 22.8 per cent.

The inevitable deduction from the foregoing considerations seems to be that the most formidable obstacle to success in the surgical treatment of carcinoma of the stomach lies in the delay of the patient in seeking surgical aid, and it is the common experience that this delay is occasioned by the insidious, stealthy course of the disease. Unless it begins close to the cardiac or pyloric orifice and thus interferes promptly with the entrance or exit of food, we cannot expect early symptoms. The great zone between these points may be designated as a silent area, where the lesion may exist and progress locally, gradually interfering with the chemical and motor functions, but so slowly as to permit of abundant compensation elsewhere. Striking symptoms, such as vomiting of blood or the passage of tarry stools, are late rather than early. Pain, which is frequently the first symptom complained of, does not characterize the growth of the tumor itself. The stomach does not possess nerves which respond to ordinary pain stimuli. It may be bruised, cut or cauterized in the non-anesthetized patient without a sensation of pain, and it is presumably not until the progress of the disease causes adhesions to neighboring structures, or by interfering with the emptying of the organ increases intragastric tension during peristaltic tonus, that painful sensations result.

When the cause of a disease is well understood a long step has been taken toward establishing an early diagnosis. The cause of carcinoma of the stomach is not yet known. The usually suggested factors apply here as elsewhere, such as fetal rests, physical, chemical or thermal trauma and chronic irritation. It is the relation between chronic ulcer and carcinoma which is at present exciting most interest and discussion. That chronic gastric ulcer should undergo malignant metamorphosis is quite in accord with the behavior of similar lesions elsewhere.

The most familiar and unquestioned examples of such a change are the epithelioma of the lower lip from irritation of the hot-pipe-stem and of the tongue from the injury due to ragged and decayed teeth, or the malignant degeneration of chronic ulcer of the lacerated cervix uteri, or of varicose ulcer of the leg. The Rochester, Minn., School believe that they have shown carcinoma developing in the edge of a chronic ulcer in a large proportion of cases, and state that 60 per cent of the operatively proved cases give an ulcer history. Smithies reduces the figure to 54 per cent, Graham to 40 per cent and Friedenwald to 23 per cent. This view is widely held, but equally competent observers hold contrary views. For instance, Ewing states that it is his opinion that carcinoma is grafted on ulcer in about 2 to 3 per cent of cases. The conflict of opinion on pathological evidence seems to depend on personal equation in the interpretation of the histological picture. The fact is that every chronic ulcer shows grossly a peripheral thickening and induration which suggests neoplasm, and, microscopically, regeneration of glandular alveoli which may be so distorted and misplaced as to suggest malignant metamorphosis, while every carcinoma, as soon as its growth has outstripped its blood supply, necessarily ulcerates at the center and presents a picture which may in some cases be confused, both grossly and microscopically, with ulcer.

The records of all cases of gastric carcinoma admitted to the Peter Bent Brigham Hospital in ten years (1913-1922) inclusive have been examined with the idea of determining the actual outcome of treatment and of studying the various factors which may lead to earlier diagnosis and more favorable results. Naturally in only those cases which came to operation or autopsy could the diagnosis be certified. In most others the criteria for a positive diagnosis rested on a positive history, a mass in the epigastrium and a characteristic filling defect on roentgenological examination. In a few cases the absence of one of these was permitted, if other minor features were present, such as achlorhydria, hematemesis or evidence of blood in the stools. Any

case affording reasonable doubt of the diagnosis was rejected. Lymphosarcoma and similar types of malignant disease have not been included.

TABLE II.—SEX AND AGE INCIDENCE

ANALYSIS OF 236 CASES

Sex.	Number of cases.	Per cent.
Male	157	66.5
Female	79	33.5

Age.	Number of cases.	Per cent.
21 to 30 inclusive	2	0.8
31 to 40 "	20	8.4
41 to 50 "	58	24.5
51 to 60 "	84	35.5
61 to 70 "	60	25.4
71 to 80 "	12	5.0

During this decade 236 cases were found conforming to the above requirements. Table II gives the age and sex incidence. The preponderance of men over women is more striking than in most statistics. It illustrates also the well-known fact that the diagnosis of carcinoma of the stomach must be considered in patients under thirty, and is common between thirty and forty. Table III presents an analysis of the symptoms first complained of by the patient in 223 cases in which the history was satisfactory in this respect. It is quite in accord with general experience and presents nothing new, but deserves attention because only when it is realized by the laity and by the general practitioner that such symptoms are significant until proved otherwise may we expect to be consulted in time to operate with reasonable prospect of cure. It is worth noting that weakness and debility, general abdominal pain, loss of weight, constipation, pallor and backache together constituted the initial symptoms in 20.8 per cent of the cases, and if we add the 9.4 per cent of patients complaining at first only of such a universal symptom as loss of appetite we find that in 30 per cent

of the cases the earliest symptoms would not be likely to suggest to the patient that the stomach was the source.

TABLE III.—SYMPTOMS FIRST COMPLAINED OF

ANALYSIS OF 223 CASES

Symptoms.	Number of cases.	Per cent.
Epigastric pain	57	25.5
Epigastric distress after eating	43	19.2
Belching of gas	25	11.2
Weakness and debility	25	11.2
Loss of appetite	21	9.4
Nausea or vomiting	19	8.5
General abdominal pain	8	3.6
Loss of weight	4	1.7
Sour stomach	4	1.7
Constipation	4	1.7
Dysphagia	4	1.7
Pallor	3	1.3
Backache	3	1.3
Mass in epigastrium	2	0.8
Vomiting of blood	1	0.4

TABLE IV.—INCIDENCE OF VOMITING BEFORE ADMISSION

ANALYSIS OF 225 CASES

	Number of cases.	Per cent.
Vomiting	153	68.0
No vomiting	72	32.0
Blood or "coffee ground"	48 of 153	32.1
No blood or "coffee ground"	104 of 153	67.9

48 patients out of 225, or 21.3 per cent, complained of bloody or coffee-ground vomitus.

INCIDENCE OF BLOOD IN STOOLS BEFORE ADMISSION

Tarry stools noted in 26 cases out of 236, or 11 per cent.

Vomiting is a symptom so objective and annoying that it is likely to be taken seriously by the patient, especially if the vomitus contains blood or such a peculiar looking substance as "coffee grounds," which resembles nothing that the patient has eaten. Table IV shows that although, as will be seen later, the

type of cases admitted was so advanced that less than 10 per cent could be subjected to radical operation, nevertheless 32 per cent had had no vomiting whatever before admission, and among the cases which had vomited, only 32.1 per cent had noted anything so unusual as blood or coffee grounds. Among the laity the impression is widely held that the vomiting of blood is necessary for a diagnosis of cancer of the stomach. Let it be noted, then, that in this series but 21.3 per cent had had bloody or coffee-ground vomitus previous to admission. Tarry stools were noted in so few instances (11 per cent) as not to constitute an important factor in early diagnosis.

TABLE V.—DURATION OF SYMPTOMS BEFORE ADMISSION

220 CASES

Time.	Number of cases.	Per cent.
Less than 2 weeks	2	0.9
2 weeks to 1 month	5	2.3
1 to 2 months	24	10.9
2 to 4 "	52	23.6
4 to 6 "	28	12.6
6 to 12 "	65	29.5
12 to 18 "	12	5.5
18 to 24 "	21	9.5
2 to 2½ years	4	1.8
2½ to 3 "	5	2.3
More than 3 years	2	0.9

Table V shows the duration of symptoms before admission. It should be read with two facts in mind: First, that the great majority of patients admitted showed the disease in too advanced a form to permit of radical operation, and, second, that while the exact duration of a case of carcinoma of the stomach can never be known there is plenty of direct evidence that in many cases the life history may be five, six, seven years or more. The above table shows that 50 per cent of the cases had had symptoms for only six months and 80 per cent for less than one year. In other words, if 80 per cent of the patients presented themselves at the very onset of symptoms, and were at once successfully

diagnosed, it is probable that only a small proportion would be found to be radically operable.

TABLE VI.—DURATION OF LIFE IN 97 INOPERABLE CASES TRACED

OMITTING OPERATIVE FATALITIES

Time.	Number of cases.	Per cent.
1 week or less	15	15.2
1 to 2 weeks	13	13.2
2 to 4 "	16	16.4
1 to 2 months	14	14.4
2 to 4 "	19	19.5
4 months or more	20	20.6

44.8 per cent of this group lived one month or less.
9.2 per cent of this group lived six months.

TABLE VII.—LENGTH OF LIFE FROM ONSET OF SYMPTOMS TO DEATH IN 83 CASES NOT OPERATED ON

Months.	Number of cases.	Per cent.
2 or less	8	9.6
2 to 6	23	27.7
6 to 12	11	13.2
12 to 18	23	27.7
18 or more	18	21.6

The standard of operability, in different clinics and in the hands of different surgeons, must vary to a certain extent, and the accurate comparison of statistics is therefore fallacious. Tables VI and VII will seem familiar to surgeons whose clinical material is drawn from large cities on the seaboard, where the large proportion of recent immigrants and the congestion of population make the level of intelligence relatively low. Table VI shows the duration of life from admission to the hospital in such cases as were considered inoperable and could be followed up. Cases explored and found inoperable were not included in order to eliminate the factor of operative trauma. It will be seen that 44.8 per cent lived less than one month and only 9.2 per cent lived six months or more. There can be no difference of opinion as to the inoperability of these cases. Table

VII gives evidence on the same point and also shows the extraordinary insidiousness of the disease. It shows that among 83 cases not operated on the total elapsed time from the onset of symptoms to death was, in nearly 40 per cent of the cases, only six months or less. And this in a disease whose average duration is probably four years!

TABLE VIII.—RELATION OF ULCER TO CARCINOMA

Ulcer history.	Number of cases.	Per cent.
Positive	18	7.6
Plausible	14	5.9
Possible	20	8.4
None	184	77.9

Pathological examination was reported to show carcinoma developing on ulcer in 4 cases in 46 cases (8.7 per cent) coming to operation or autopsy.

The relation of a history of ulcer to carcinoma in the total of 236 cases appears in Table VIII. Here obviously the bias and judgment of the investigator must play a rôle. The types of histories classified under the heading "positive," "plausible," "possible" and "none" are indicated satisfactorily by these words. A patient who described in his antecedent history any symptoms, however trivial, which might be associated with gastric digestion was placed in the "possible" group, and only those who categorically denied abdominal pain, distress, indigestion, nausea, vomiting or belching of gas were considered to have no ulcer history. Certain cases giving a gastric history somewhat suggestive of ulcer of three years' duration, which were found at operation to present an advanced carcinoma, were considered to have been malignant from the beginning, because in the judgment of the operator the growth was consistent with that period of development. Under this classification 77.9 per cent were unequivocally negative. The two intermediate doubtful groups may doubtless be assigned according to the bias of the individual investigator. A bit of evidence from a different source exists in the report of the pathologist of car-

cinoma developing on ulcer in 4 instances among 46 cases which came to operation or autopsy, an occurrence percentage of 8.7, which corresponds rather strikingly to the 7.6 per cent of positive ulcer histories. The relation between the presence of free hydrochloric acid and a history of ulcer does not appear intrinsically important. Seventy-three and nine-tenths per cent of the cases showed achlorhydria; and of the remaining 26.1 per cent showing the presence of hydrochloric acid, 13.9 per cent gave a positive antecedent ulcer history.

TABLE IX.—ANALYSIS OF OPERABILITY OF 236 CASES

Treatment.	Number of cases.	Per cent.
Inoperable for either exploration, palliation or cure	124	52.5
Explored and found inoperable for either palliation or cure	24	10.1
Palliative operation for obstruction or perforation	53	22.4
Radical operation	23	9.7
Operation refused	12	5.0

In presenting a statement of the operability of the 236 cases under consideration it is realized that there can be no just measure of its accuracy or fallibility. No two surgeons are alike in their judgment as to operability or their skill in operating. Table IX represents the judgment of a small group of surgeons whose aim is not to permit the ideal of a low operative mortality to withhold from a patient any reasonable hope of cure. Table IX shows that 62.6 per cent of all cases admitted had to be denied any possible hope of palliation or cure, while in only 9.7 per cent was it considered feasible to attempt a radical operation. Among the 5 per cent who refused treatment were a few who, on exploration, might have been added to this group. Two patients are remembered who suffered a possible miscarriage of treatment which resulted in a palliative rather than an attempt at a radical procedure. Making due allowance for these instances, it seems to be a fair statement that in about 10 per cent of all cases admitted to the hospital a radical cure could be attempted.

TABLE X.—OPERATIVE MORTALITY (100 CASES)

Treatment.	Number of cases.	Number of deaths.	Mortality, per cent.
Exploration only	24	5	20.8
Palliative operation for obstruction or perforation	53	7	13.2
Radical operation	23	3	13.0

In this table is tabulated the mortality in the 100 cases subjected to some form of operation. Simple exploration showed the high mortality of 20.8 per cent for which no apology is made. These cases were all obviously radically inoperable; the exploration was in most cases done under novocaine anesthesia, with the idea of palliating the suffering of the terminal stage of the disease. The expediency of exploring will depend on the temperament and point of view of the surgeon and his patient. The latter is in a pitiable condition, regurgitating the liquids he tries to take to quench his thirst, dehydrated, kept alive by daily subcutaneous saline infusions and rectal alimentation. He may grasp at the possibility of relief for a few weeks by a simple palliation, at the expense of a high risk of more speedy termination of his suffering. The surgeon need not reproach himself if he is the agent of this relief in whatever way it may come. The palliative operations for obstruction or perforation and the radical gastrectomies carried nearly the same mortality, about 13 per cent.

Here are analyzed the end-results of the palliative and radical operations. In regard to the former procedures, comparison may be made with Table VI, where it was shown that of patients not operated on 20.6 per cent lived four months or more while 73.3 per cent of the patients afforded palliative operations lived a similar period. The two series are not exactly comparable, as the non-operative cases were, on the average, more advanced, but when considered also with reference to the relief afforded by gastroenterostomy it appears that attempts at palliation are abundantly justified.

TABLE XI.—ANALYSIS OF OPERATIVE RESULTS

PALLIATIVE OPERATIONS
(30 Cases Traced)

Lived.	Number of cases.	Per cent.
Less than 1 month	1	3.3
More than 4 months	22	73.3

RADICAL OPERATIONS
(20 Operative Recoveries, All Traced)

Less than 12 months	4	20.0
1 to 1½ years	6	30.0
2½ to 4 "	2	10.0
7 years	1	5.0

7 patients are now living:
1 at the end of 1 year.
1 " " " 1½ years
1 " " " 3 "
1 " " " 4 " 11 months.
1 " " " 5 " 10 "
1 " " " 6 " 6 "
1 " " " 7 " 9 "

3 cases, or 13 per cent, of operable cases, or 1.2 per cent of all cases seen show five-year "cures."

In the case of the radical operations it is fortunate that all have been traced. They are arranged in two groups: Those who have died and those still living. The tabulation shows 13 per cent of the radically operable cases living at the end of five years without evidence of recurrence, which is equivalent to 1.2 per cent of all cases of carcinoma of the stomach seen at the Brigham Hospital. Another patient, living at the end of four years and eleven months, when this paper was written may justly be included. Yet another, who lived seven years, developing an apparently independent cancer of the breast and dying of spinal metastases without known local recurrence of the carcinoma of the stomach, would, if included, still further improve the statistics.

Such a record of failure to cure the most common type of

malignant disease is regrettable, but the most discouraging feature is that it is difficult to see how any very great improvement may be achieved. Early diagnosis and prompt resort to surgery appears to be at present the only key to success, but if the disease in most instances runs the greater part of its course so insidiously that the patient is quite oblivious of it, and if the first symptoms are apt to be so trivial as not to attract serious attention, it is unlikely that rapid progress can be made. It is desirable that both physicians and patients should pay less regard to the text-book picture of the disease in its fully developed stages, and should realize that any obscure symptom-complex, however trivial, especially if it involves any change in the previous digestive habit of the individual, must be investigated and proved to have no malignant basis. Of methods of diagnosis, undoubtedly the most accurate by a wide margin are fluoroscopy and radiography after the ingestion of the opaque meal. In the series under consideration, 93 per cent showed a pathognomonic picture leading to correct diagnosis, 3.5 per cent were suggestive and in only 3.5 per cent was a negative report made. This report included the war, when, owing to a changing and depleted staff, the work was not always satisfactory. It is likely that in experienced hands in the future an accurate positive diagnosis will be made in at least 97 per cent of the cases.

Carcinoma of the stomach is curable by radical surgical operation, at the expense of a high but justifiable mortality. Success depends, as in most surgical conditions, on early diagnosis and prompt recourse to treatment.

DISCUSSION

Dr. George W. Crile, Cleveland:

I appreciate very much indeed the paper by Dr. Cheever. To be sure, there is a discouraging note in it, but I know from others at the Lakeside Clinic and also from my own clinic that we have a discouraging side also, and I believe that in every clinic in the world the treatment of cancer of the stomach carries a discouraging note. From a review of the Lakeside Clinic cases, I understand that the average time from the onset of the first symptom to the time of admission of the patient is five months. In connection with the inoperable cases, I may say that these patients are not wholly from the unintelligent class. Physicians and surgeons have been among my patients. There may be some cases of inoperable cancer in this room. For this reason I think that Dr. Cheever's last remark is particularly good. If there is any doubt regarding any symptom, an *x*-ray examination should be made at once; this will aid in the diagnosis, although even then it may be too late to expect a cure from operation.

Dr. F. B. Lund, Boston:

I have not much to say other than that I have two patients, one a man, who has survived in good health after resection for carcinoma of the stomach, and one, a woman, who is perfectly well after seven years.

Dr. A. J. Ochsner, Chicago:

I should like to refer again to an observation that was made in our clinic, namely, the cases which show no previous history of ulcer. A very large majority of them have a distinct history of a previous ulcer if you go far enough back. The distress from the carcinoma is so marked that the average patient forgets this and the intern in the hospital who takes the history does not go far enough back.

When the pathologist gets the specimen all of the marks of a previous ulcer have been obliterated by the cancer, as it has progressed and has destroyed what is left of the ulcer.

I should like very much to have some of you take the cases that you have in your hospital now and have the present history read, and then question that patient and you will find, I believe, the same thing that I have found in many of these cases, a previous ulcer history, when you come to take the history yourself.

So far as the treatment of cancer is concerned, I am more and more convinced that it must be controlled by prophylaxis. We know that the manure-eating races, such as the Japanese and the Chinese, or those that eat manure practically every day, are the people that have cancer of the stomach. You can go through the Hoffman statistics and you can pick out the manure-eating peoples. The Mexicans, Esquimaux and those people who do not fertilize their vegetables with manure or human excrement do not have cancer of the stomach. The late statistics of Lukac, in Berne, Switzerland, are probably the best in the world, and I think they show this very clearly. Hoffman's statistics also show that it is the manure-eaters who have cancer of the stomach.

DR. CHEEVER (in closing):

The discussion of the relation of ulcer and carcinoma would be, I am sure, very interesting. I only wish to call attention to one other fact from our clinic, namely, that of the cases of gastric ulcer which have not been excised or not operated on at all, for one reason or another, hardly any seem to have developed carcinoma. Naturally these are not proved cases, but the fact seems significant.

No better proof of the difficulties of the pathologist in this connection could be had than the communication of Dr. Balfour a year ago before this Association, when he showed, in discussing the expectancy of life after operation for ulcer, that a reëxamination of the tissue blocks from cases previously diagnosed as ulcer showed carcinoma in many instances. Thus was explained the reason why so many of his ulcer cases later died of carcinoma of the stomach.

CANCER OF THE COLON

By ROBERT T. MILLER, Jr., M.D.
BALTIMORE, MD.

The activities of the American Society for the Prevention of Cancer and allied groups have tended in a way to center the interest of the profession and of the lay public as well upon superficial cancers. There can be no doubt that this educational campaign has resulted in great improvement in the general situation, for persons afflicted with malignant disease of the mouth, the skin or the breast are today seeking advice much earlier than formerly, and in addition many doubtful conditions proven on close study to be benign are coming to observation; in a general way the idea that it is best to seek help early seems to be slowly making progress against the hitherto prevailing sentiment of the lay public to conceal such afflictions. Cancers of superficial situation, of course, form the most favorable group for this educational type of attack, since they are usually obvious and the patient's attention is attracted early in the disease. A different problem, however, is presented by deeply situated cancers, for, rather than the growth itself, it is commonly the secondary effects of the growth which attract attention, and these are not infrequently so insidious in onset and development that the patient fails to appreciate their significance until too late. It is not uncommon to find that the secondary effects, that is to say, the symptoms, of a deeply situated cancer have been regarded so lightly by the patient that the physician's diagnosis of cancer quite fails to convince the sufferer of the seriousness of his malady. Pain is, unfortunately, not a symp-

tom in the early stages of malignant growth. Pain is a late sign and due not to the growth itself but to the secondary effects of the growth; in gastrointestinal cancers pain is perhaps most frequently due to infection, which does not occur until the surface has been broken, and even then with an open lesion severe acute pain is not the rule. As a corollary, cancers of the gastrointestinal tract usually cause the patients to seek help because of things other than pain; but when a cancer has been present long enough to cause these things—as, for instance, a tumor, loss of weight and strength, or anemia—there is but little chance of cure. The percentage of cures of cancer of the stomach or of the rectum is very low. There is a rather general opinion that cancers of the gastrointestinal tract which produce obstruction are favorable as compared to those which do not produce obstruction, since this feature forces the patient to seek advice. Cancer of the colon is commonly thought of as a tumor prone to produce obstruction. We find furthermore a fairly frequent expression of the opinion that cancers of the colon are relatively slow in their rate of growth and that they metastasize late. If these opinions represent the truth of the matter, it must follow that the ratio of cure following resection is materially higher for the colon than elsewhere in the gastrointestinal tract.

The cases of cancer of the colon, exclusive of the rectum, which have been admitted to the Johns Hopkins Hospital from 1889 to 1919, together with such as are represented by material sent to Dr. Bloodgood's laboratory during this period though operated upon elsewhere, have been studied in an effort to ascertain, among other things, whether these commonly held opinions have an actual basis in fact. The circumstances under which any such group of cases has been assembled are of importance when one attempts to interpret the facts resulting from such a study. This series represents the work of a good many operators, perhaps fifteen in all, and a fairly large percentage of the operations were made by men relatively young in surgery. Practically all of the operators were working under the same conditions, and their surgical efforts represent the result of identical

training, but in respect to experience, surgical judgment and technical ability this series is not entirely comparable to the work of one man. Treatment was uniformly based upon the conviction that if excision was to be made at all, the more radical it could be made within the limits of safety the better; in other words, when feasible there was made a deliberate effort not merely to relieve the patient of an ulcerating mass or of obstruction, but to effect a definitive cure. The primary growth

FIG. 1.—P.N. 32,666. Adenocarcinoma of the transverse colon, gross specimen. The bowel has been divided longitudinally. Note the large fistula from the colon into the stomach. The excised portion of the wall of the stomach presents the shape of a mushroom on the superior edge of the bowel.

was excised, and insofar as the conditions governing the individual case permitted, attempt was made to remove also the glands draining the site of the growth. During this period of thirty years the scope of the operation of resection has been gradually extended until, at present, there would seem to be little hope of material improvement in this regard. If then this series of cases may be accepted, within limits, as indicating the effectiveness of our present-day treatment, a study of the results would

appear to be of value. The group is made up of 129 cases of cancer of the colon exclusive of the rectum, and covers a period of thirty years beginning in 1889.

Consideration of Clinical Features. Of the cases studied 77 are male and 42 female, information as to sex being lacking in 10. The ages are shown in the following table:

17 years	1	
20 to 29 "	12	
30 to 39 "	17	
40 to 49 "	28	46.5 per cent of all cases
50 to 59 "	32	
60 to 69 "	21	
70 to 79 "	6	
80 to 84 "	2	
Not stated	10	
Total cases	129	

Fifteen per cent of the patients were less than thirty-five years of age.

There are three quite distinct groups to be recognized at the time these patients seek advice; namely, those in acute intestinal obstruction or who have survived such an attack in the past, those who have had definite chronic partial obstruction which has never become acute, and finally those whose history offers no evidence of obstruction. These three groups apparently have a definite mutual ratio, the acute obstruction group representing 19 per cent, the chronic obstruction group 41 per cent, and the non-obstructive group 39 per cent. In other words, of 10 cases seeking advice 4 will give a definite history of chronic obstruction, 4 will present no evident features of obstruction, and 2 either will be in acute obstruction or will give the history of such an attack from which they have recovered. The fact that identical figures were found some years ago by Dr. Bloodgood in an unpublished study suggests the constancy of this group relationship.

The sex ratio within these clinical groups is of little importance; there is a preponderance of men in the chronic obstruction group

and of females in the non-obstructive group. The average age in these two groups is about fifty years, whereas in the acute obstruction group the patients are a little younger (forty-six years); the average age of the females in the acute obstruction group is forty-one years, and that of the males is fifty-one years. The site of the tumor may be tabulated as follows:

SITE OF GROWTHS IN THE THREE CLINICAL GROUPS

Site of growth.	Number of cases.	Per cent.	Acute obstruction.	Chronic obstruction.	Non-obstructive.
Cecum	50	38	2	24	24
Ascending colon	5	4	1	1	3
Hepatic flexure	12	9	2	6	4
Transverse colon	7	5	4	2	1
Splenic flexure	8	6	2	3	3
Descending colon	6	5	2	1	3
Sigmoid	40	31	12	16	12
Hepatic flexure combined with second growth in ascending colon	1				

Among the chronic obstruction cases the outstanding feature is the history of recurrent attacks of colicky pain, nausea and vomiting, without apparent cause or perhaps ascribed to some indiscretion in diet and usually relieved without great difficulty by catharsis. In a few cases (6 of 53) these attacks are unmistakable, for the patients describe the onset of "cramps," leading up to a rather severe colic, which culminates in a gurgle with the immediate relief of pain, and after the lapse of a brief period of comfort a repetition of this cycle. There is frequently a marked tendency to constipation, occasionally diarrhea, and at times (11 cases) gross blood in the stools is recognized by the patient. Moderate abdominal pain of fairly accurate localization is not uncommon and there is a complaint of gastric distress or of an indefinite discomfort. Among our cases about every fifth patient in this group has discovered an abdominal mass.

Forty per cent of the cases do not give a history of obstruction, but with them abdominal pain of an indefinite character is

usually present. The pain is rarely severe and is variously described as "dragging," "a sense of weight," or "discomfort," the patient at times placing it rather consistently, as, for instance, in the epigastrium or the right lower quadrant. There is a tendency to refer symptoms to the stomach, and frequent mention is made of distress or soreness in the upper abdomen,

FIG. 2.—P. N. 10,253. Cancer of the colon. Gross specimen.

belching, loss of appetite and kindred complaints. There has been some confusion with chronic appendicitis. A tendency to diarrhea is perhaps more frequent than constipation and is occasionally marked; at times blood in the stools is present. About every third patient in this group has an abdominal mass.

The acute obstruction group is made up of 25 cases, 5 among

them giving no history of trouble preceding the advent of an "unheralded" complete obstruction. The history of each of the remaining 20 falls naturally into one or the other groups just

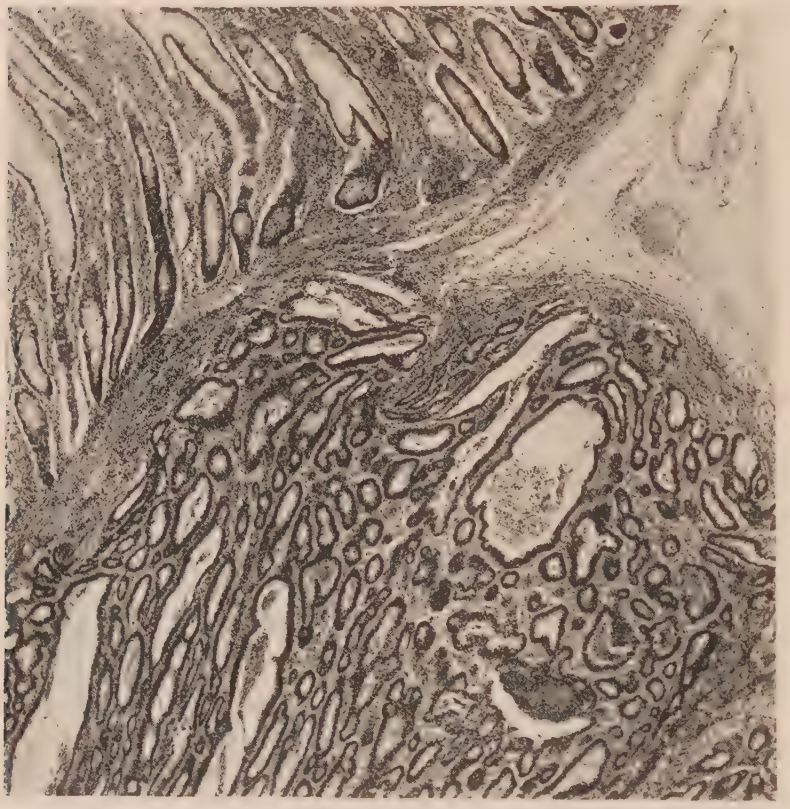

FIG. 3.—P. N. 28,918. Adenocarcinoma of the colon. A large majority of the cancers of colon are of this type. The picture shows direct extension of the growth along the bowel wall, undermining the normal mucosa; this is seen very frequently.

outlined, differing only in that the patient had survived one or more stormy attacks of acute obstruction, which were apparently complete for the time being but did not prove fatal. The 5 cases of "unheralded" obstruction represent 4 per cent of the

entire series, and if to this 4 per cent who have no previous history of obstructive symptoms we add the 40 per cent who at no time offer evidences of obstruction, it is seen that almost

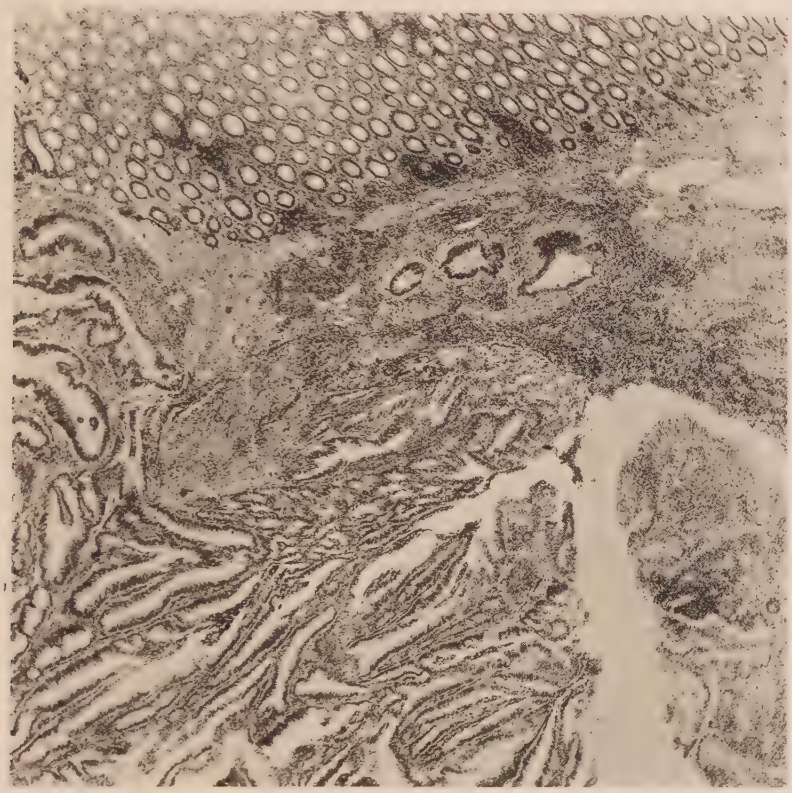

FIG. 4.—P. N. 31,610. Adenocarcinoma of the colon, showing direct extension of the growth in the bowel wall, undermining the normal mucosa. The advancing edge of the cancer is well shown in the lower right-hand portion of the picture.

one-half (44 per cent) of all cases of cancer of the colon lack this tell-tale symptom, which is commonly regarded as characteristic of the disease. The diagnostic importance of this fact is obvious. Our figures do not support the opinion that cancer of the colon

very generally produces obstruction. However, as has just been pointed out, close study of the histories shows that, with few exceptions, the cases show certain symptoms which can hardly escape the patients' recognition, and that even though evident partial obstruction is not present in more than one-half, yet those lacking this symptom present other evidences of disease which are quite as obvious and whose explanation would be just as vigorously sought if their possible significance were understood by those so afflicted.

The duration of symptoms in all cases here represented averaged sixteen months. In general, the patients are seeking treatment somewhat earlier today than they did twenty-five years ago, but not to a striking degree, for when this is studied by periods of five years it is found that the present-day duration of symptoms is thirteen months as against nineteen months twenty-five years ago. Moreover, the evidence of this series shows that the shortening of this period affects but one of the three clinical groups; the acute obstructions and the chronic obstructions appear to be coming to treatment a little later than they did years ago, and the only group seeking relief earlier than formerly is the non-obstructive group, in which twenty-two months represents the average duration of symptoms thirty years ago and eight months represents the average duration today. Inquiry developed the fact that this improvement was not due to the advent of the *x*-ray as a help in diagnosis; before this method of examination was in current use there had been a drop from twenty-two to thirteen months in duration of symptoms.

Judging from this series, it appears that for many months these patients consistently present symptoms which can hardly escape recognition, and yet, in the face of this fact, they fail to appreciate the significance of these symptoms or to investigate the cause of the trouble. This state of affairs apparently presents an excellent opportunity for an effort to bring the public to understand that persistently recurring partial obstruction, or unexplained abdominal pain accompanied by blood in the

stools, may be a warning of serious trouble. Reduction of the duration of symptoms offers more than further technical elaboration of the operative treatment.

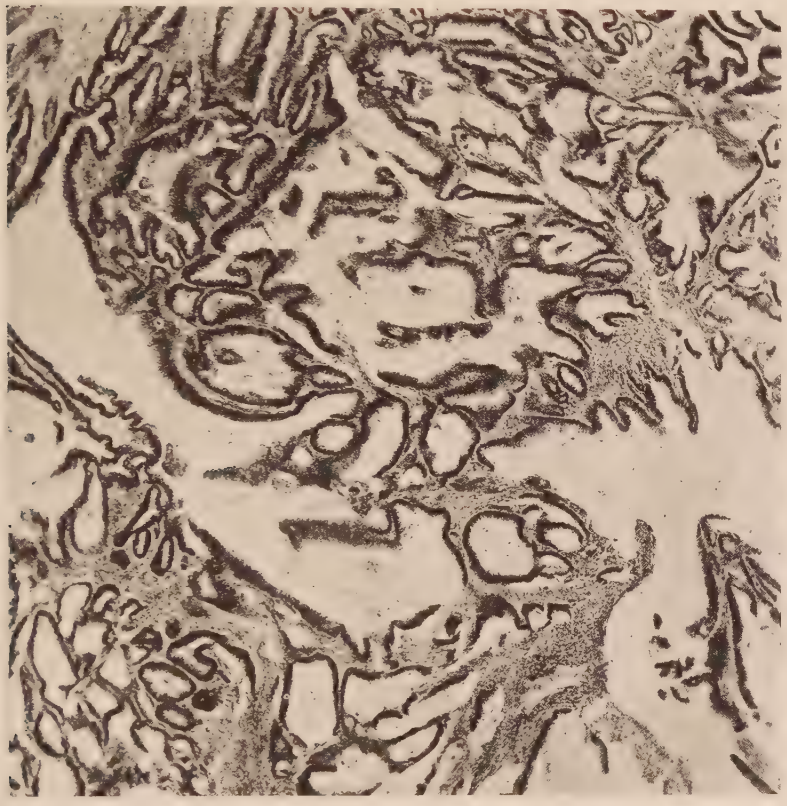

FIG. 5.—P. N. 28,443. Colloid cancer of the colon. The growth shows a definite tendency towards a glandular arrangement, with marked production of colloid. In frequency of occurrence this type of growth ranks second, adenocarcinoma without colloid production being first.

PATHOLOGICAL FEATURES. The tumors are almost uniformly adenocarcinoma and show a definite tendency to reproduce roughly the glands in the wall of the bowel. Most of the growths have a decided excess of epithelium with a correspondingly

limited amount of fibrous tissue, so that there is usually produced a fairly large mass. The extreme scirrhous type, resulting from fibrous overgrowth and producing a marked degree of obstruction, is infrequent in this series. There is found at times

FIG. 6.—P. N. 29,017. Carcinoma of the colon. There is a marked tendency toward the production of fibrous tissue, the resulting picture rather suggesting scirrhous cancer. The tendency of the epithelium to maintain a glandular arrangement is still evident. This is the least common type.

a certain amount of colloid degeneration. In the earlier cases perforation of the bowel with a secondary abscess is not infrequent, there being 16 such cases, the latest of which was recognized in 1913. Excepting 1 case, which apparently shows a

carcinoma developing from a benign adenoma, there was found very little evidence of cancer developing in a preëxisting lesion. The presence of diverticula or of benign ulcers was not observed; if such preëxisting lesions had served as the point of origin of a cancer it is probable that they would have been so completely obscured by the long-standing malignant disease as to escape recognition. These tumors are of course almost invariably single, but there are 4 cases in the series which seem to represent simultaneous development of cancers at two different points. Cancers of the cecum and sigmoid account for 70 per cent of the tumors of this series, these two sites being about of equal frequency; the remaining 30 per cent are scattered indifferently along the other parts of the colon. One-half of the acute obstructions were due to cancers of the sigmoid; almost one-half of the tumors in the chronic obstruction and non-obstructive groups were of the cecum.

Treatment. Among 129 cases there were but 70 treated by resection; that is to say, in barely over 50 per cent was it considered advisable to attempt resection. The earlier cases date back twenty years or more to a period when tardy diagnosis and doubtful technic reduced the number of operable tumors. In 70 resections there were 24 postoperative deaths, an operative mortality of 35 per cent. This is undoubtedly high. In contrast to it stands the fact that, since 1919, 14 resections have been made with but one death, a resection of the transverse colon and stomach for cancerous gastrocolic fistula. The cause of death in these 24 postoperative fatalities was as follows: peritonitis, 8; obstruction, 3; embolism, 3; shock, 2; volvulus, duodenal fistula, bronchopneumonia, lung abscess, uremia, non-functioning anastomosis, "fulminant recurrence," each 1 case, with the cause not stated in an additional case. Of the 8 peritonitis deaths 2 followed the comparatively simple procedure of mobilization of the growth, carried out as the first stage of a proposed Mikulicz operation; these occurred early in the series and probably represent tumors that would be considered inoperable today. Six peritonitis deaths were due to

failure of the intestinal stitch, four times in lateral and twice in end-to-end anastomoses, all but one of which concerned the sigmoid. When one examines the operative method followed in the 24 fatal cases, it is found similarly that there is a higher

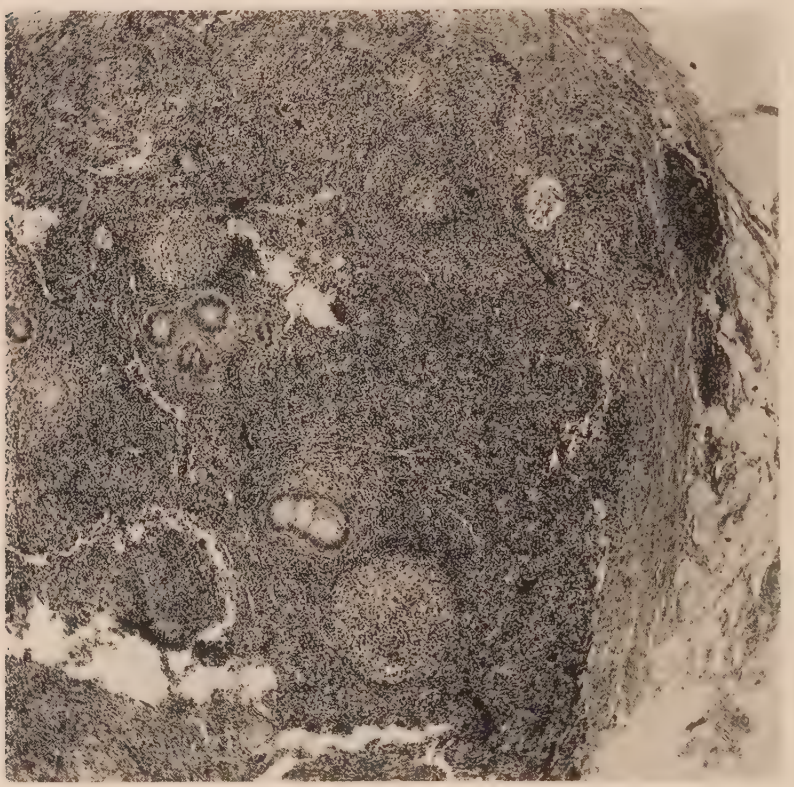

FIG. 7.—P. N. 31,610. Adenocarcinoma of the colon, early metastasis to a lymphatic gland. Note the persistent tendency toward a glandular arrangement of the epithelium.

mortality ratio among the lateral anastomoses than the end-to-end sutures, namely, 34 per cent as against 17 per cent, and even though these deaths are not all due to peritonitis resulting from insecure suture, nevertheless the contrast in the figures is

striking and possibly significant. Of late years there has been rather a tendency to prefer lateral anastomosis to end-to-end anastomosis, on the assumption that the threat of necrosis of the bowel, due to unavoidable operative interference with its

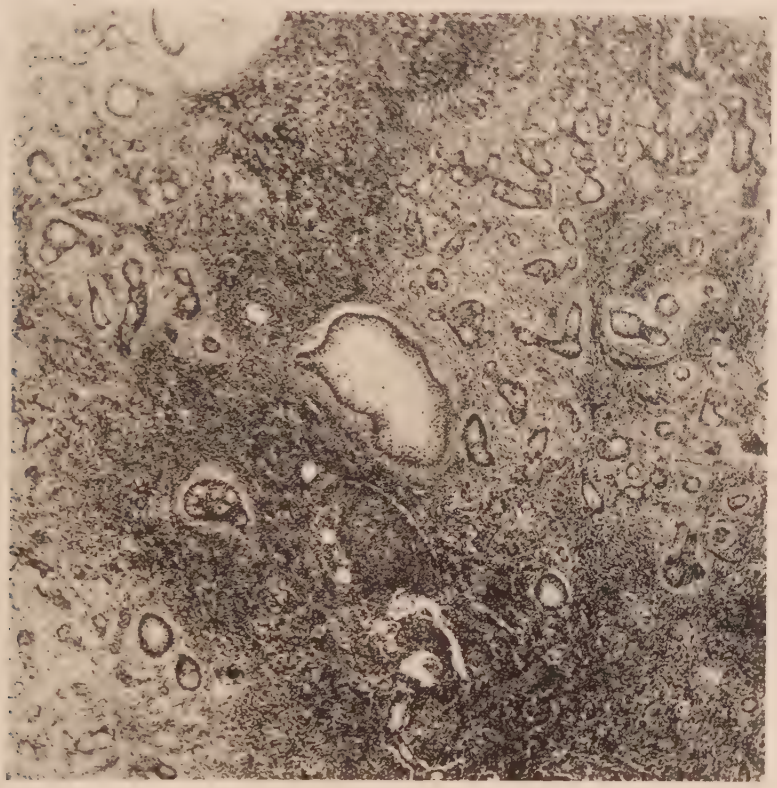

FIG. 8.—P. N. 31 835. Colloid cancer of the colon; metastasis to a lymphatic gland. The structure of the lymphatic gland is still seen in a transverse strip across the middle of the picture; elsewhere the carcinomatous growth has largely replaced the lymphatic tissue.

circulation, is more adequately met; but the figures of this table, while by no means conclusive, do not seem entirely to support this impression. It is probably nearer the truth to admit that neither type of anastomosis is dependable if there is any question

as to the adequacy of the circulation, and that it is safer to meet this operative problem either by fixing both stumps in an extraperitoneal position or, where possible, by resecting enough gut to ensure viable tissues.

There is a marked contrast in the risk involved in resection and suture in the various regions; thus operations on the transverse colon had a mortality of 57 per cent, on the left colon of 41 per cent and on the right colon of 25 per cent, which conforms rather accurately to the general feeling among surgeons today as to the relative danger. There was a high mortality in 5 resections of the descending colon, among which 3, or 60 per cent, died, and in 4 resections of the splenic flexure, of which one-half died. This bears out the feeling expressed by Dr. John A. Hartwell in a paper read before this association in 1917. The lowest mortality, namely, 24 per cent, is found in resection and lateral anastomosis on the right side, and, excluding the few Mikulicz operations, the highest mortality-rate is in lateral anastomoses of the transverse colon, namely, 75 per cent. The transverse colon seems to be a particularly dangerous area, and our figures may perhaps serve as an argument for a wider resection than many surgeons have been accustomed to make. There is definitely presented the question whether, in cancer of the right or of the transverse colon, it is not wiser to remove the growth and all of the large bowel proximal to it and to restore the continuity of the tract by a lateral anastomosis of the ileum with the remaining colon. Our figures suggest that, if the patient's condition permits, the intestinal suture will be more dependable if this plan is followed than if an attempt is made to restore the continuity by anastomosis of the proximal and distal loops of the colon; but, as will be pointed out a little later, while extending the operation to this limit seems to offer more safety from the standpoint of suture, it fails to offer any additional security with reference to recurrence of the growth. The indication for this extension of the operation, therefore, is not drawn from the figures referring to ultimate cure, but solely from the statistics referring to the immediate postoperative result.

Among the clinical groups the lowest mortality from resection was in the acute obstruction group; apparently this was due to the fact that most of these cases were treated by a preliminary ileostomy or colostomy. Six were submitted to immediate resection, with one postoperative death. Nineteen were submitted to preliminary colostomy; these were obviously the sickest patients of the group, and among the 19 there were 6 deaths following colostomy, but among the 13 surviving colostomy, 12 were resected without immediate postoperative mortality. Thus the resections in the three clinical groups compare as follows with reference to mortality: acute obstruction, 20 per cent; chronic obstruction, 39 per cent; non-obstructive, 38.5 per cent.

To sum up: In 70 resections scattered over a period of thirty years there has been a mortality of 35 per cent, and this mortality has been higher with resection of the left colon than the right colon. The most dangerous region has proved to be the transverse colon and its distal extension. No doubt this high regional mortality is due not alone to circulatory difficulties but also to the richer and more virulent bacterial flora of the lower operative field. End-to-end suture in this series has been attended by a lower mortality ratio than lateral anastomosis; but rather than indicating great advantage for either method of restoring continuity of the gut, our figures suggest that, with tumors of the right or transverse colon, if the patient's condition permits, it is perhaps better to excise the cancer and all of the colon proximal to it, restoring the continuity by anastomosing the ileum to the remaining portion of the colon, rather than to anastomose colon to colon after resection of no more than the growth-bearing sector of the bowel.

Analysis of Five-year Cures. Practically all of these patients have been traced and their ultimate fate is known. There are only 13 five-year cures. This represents 10 per cent of the admitted cases, 19 per cent of the resected cases, and 28 per cent of those surviving resection. In other words, the five-year cures represent 1 in 10 of all admitted cases, 2 in 10 of every

resected case, and 3 in 10 of every resection surviving operation. In the face of the figures, it requires a considerable degree of optimism to regard cancer of the colon as a "favorable" type of the disease.

Of the 13 five-year cures, 8 came from the clinical group showing chronic obstruction, 3 from the acute obstruction group, and but 2 from the non-obstructive group. Of the 3 cases from the acute obstruction group, none had shown any obstruction symptoms in their past histories; 1 of these 3 was of the "unheralded" complete obstruction type and had had no previous symptoms, the other 2 had each had abdominal symptoms for two years, but not obstructive in character. Thus in 13 five-year cures only 8, or 60 per cent, had attacks of partial intestinal occlusion which finally forced them to seek advice. It was shown above that about 56 per cent of all cases of cancer of the colon have a history of partial obstruction. These two figures, viz., 60 per cent and 56 per cent, are practically identical; their close correspondence forces one to the conclusion that the symptom of chronic obstruction has proved of little aid toward early diagnosis. If the partially obstructing cancer had forced recognition of its presence earlier and so offered better chance of cure than the others, we would find a distinctly higher cure ratio among those of the first mentioned type; the fact is that our figures show almost the same proportion of chronic obstruction histories in all cases as in the five-year cures. The discrepancy between this fact and the rather generally held opinion is evident.

The relation between the length of time the disease has been present and the chance of cure is clearly shown; the 8 five-year cures in the chronic obstruction cases had an average duration of symptoms of six months as against an average duration of eleven months for all the cases of this group. Among the 51 cases of the non-obstructive group the average duration of symptoms was 19 months, but the 2 cures had shown symptoms for only six and a half months preceding resection. In the acute obstruction group there is no difference in this respect between

the 3 cured cases and the 22 uncured cases, and it is an interesting fact that only 1 of the 3 came to operation because of acute unheralded obstruction.

The site of the growth in the cured cases is of interest. The first five-year cure of which we have record was operated upon in 1894 for carcinoma of the cecum, and the second was also a right-sided growth, a cancer of the hepatic flexure resected in 1899. Of the 13 cases 6, or nearly one-half of the five-year cures, were carcinoma of the cecum, 2 were carcinoma of the hepatic flexure, 1 was a cancer of the transverse colon, and only 4 were cancers of the sigmoid. It has been held by many observers that, from the standpoint of cure, the sigmoid is a relatively favorable site because of the frequency of early obstruction with this situation, and it is true that one-half of the acute obstructions occur at the sigmoid, but it has just been shown that the potential help of obstruction as a symptom has not as yet been developed; only 4 of 13 five-year cures had cancer of the sigmoid in spite of the decided tendency toward obstruction at this site.

The type and extent of operation is of very considerable interest. Eleven of the 13 cases were treated by immediate resection and anastomosis; 2 acute sigmoid obstructions in females were treated by preliminary colostomy and secondary resection. In the amount of gut removed there is great variation among the 13 cases, and it appears that, so far as recurrence is concerned, this point is of relatively slight importance provided all of the primary growth is excised. In 8 instances the resection was extensive in the sense that the tumor was removed together with a generous amount of obviously healthy bowel wall; the tissue of only one of these showed metastases to the glands. There were 5 limited resections, viz., 10 cm., 9 cm., 4 cm., 20 cm. (which, however, cleared the edge of the growth on one side by only 3 cm.) and 1 of less than 4 cm.; none of the 5 showed involved glands. In spite of this variation in extent and more particularly of the decidedly limited amounts removed in at least 2 cases, viz., 4 cm. and less, all of the operations accomplished the same result in that the patients were

clinically free from disease for at least five years and in most instances longer.

All of the material was studied carefully, and, excepting that from one of the extensive resections, no metastatic glands were found; thus 12 of the 13 cured cases were operated upon at a time in the development of the tumor when complete local removal, no matter how limited a resection this implied, accomplished as much as any operation, regardless of its extent. The 1 case showing metastatic glands remained well over six years and replied to the follow-up letters willingly and promptly; at the end of six and a half years her replies stopped abruptly, and it has been impossible to obtain any further information. Although we are ignorant of her fate, it is altogether probable that recurrence of the cancer explains her disappearance, this assumption being strengthened by reason of the low rate of cure in this series as well as by the knowledge that a considerable proportion of the recurrences appear after the end of the fifth postoperative year. If our assumption is correct, there remains no evidence in this series that cancer of the colon is curable by operation after it has invaded the lymphatic glands. It is unfortunately true that but few of these cases will come to operation before the glands are involved. If it is equally true, as our evidence apparently indicates, that cancer of the colon in this stage of development is rarely if ever curable by operation, there is every reason for us to strive by intelligently directed educational efforts to bring these cases to operation earlier, while they are still curable, rather than to extend the limits of operation. Judging from this series, it seems quite probable that just as much can be accomplished by a limited operation which clears the primary growth as by any operation; there would seem to be no indication for exceedingly wide resections other than circulatory conditions of the colon which appear at times to make ileocolostomy safer than colocolostomy.

There is little to be said of the type of tumor found in the cured cases. Twelve were of the usual adenocarcinomatous character, growths in which the epithelial elements clearly predominate,

forming more or less bulky masses which present, in the lumen of the gut, an irregular ulcerating surface outlined by a thickened rather elevated edge. The ulcerating surface in this type of growth is apt to bleed easily. There is only one scirrhous tumor among the 13; this case is a nine-year cure and the details are sufficiently interesting to merit recording. Following the drainage of a subacute, thick-walled gall-bladder, the patient had a rather stormy convalescence, and on the twentieth day was explored because of a diagnosis of pancreatitis. During the approach to the pancreas the transverse colon was drawn out of the abdomen, and there was found in its distal half a small scirrhous stenosing cancer, which was removed with a rather narrow margin on each side of the growth, no attempt being made to remove the glands. The patient made an uneventful recovery, and nine years after operation was well.

RECURRENCE. Among the 26 instances of proved or probable recurrence following resection there are 16 in which the date at which the recurrence was first definitely recognized is known. The information concerning these 16 is recorded in the appended table:

DATE OF RECURRENCE

Postoperative year.	Number cases.	Per cent of total number cases with recurrence of known date.	
First	8	50.00	75 per cent
Second	2	12.50	
Third	1	6.25	
Fourth	1	6.25	
Sixth	1	6.25	25 per cent of all recurrences appear after the fifth year
Seventh	1	6.25	
Eighth	1	6.25	
Sixteenth	1	6.25	

Fifty per cent appear within the first year and 12.5 per cent during the second postoperative year; after that time, however, there seems to be a definite tendency toward tardiness, amounting in a few to marked delay. It is not reassuring to realize that the first five years elapsing after successful resection account for only 75 per cent of the recurrences which will appear; 25 per

cent are first recognized after apparent freedom from disease for more than five years. The length of time which must elapse after operation before a case may be regarded as actually and finally cured is altogether obscure; it is certain, however, that five years' freedom is not sufficient. In addition to the 16 cases whose date of recurrence is known there remain 10 cases who left the hospital alive but were lost; it is probably not far from the truth to regard these 10 as recurrence deaths, and our figures then show 26 recurrences, which represents 56 per cent of the resections surviving operation.

There are 2 cases not taken account of in the figures presented above which illustrate very definitely the insecurity of regarding five years' postoperative freedom from disease as equivalent to a cure. The first of these cases was a woman, aged thirty-eight years, who came to operation because of dyspepsia and mild constipation present for three and a half months. At operation there was found a cancer of the cecum, which was resected. Sixteen years later this patient died of cancer of the liver; although it is not absolutely certain that this was a recurrence, the probability of such being the case is quite apparent. The second instance is a woman, aged fifty-nine years, admitted in acute obstruction, which was treated by a preliminary colostomy, followed a little later by resection of a cancer of the transverse colon. Five and a half years later, laparotomy disclosed a mass of carcinomatous glands in the right lower quadrant, which were regarded at the time of operation as metastases from the growth in the transverse colon. Here are 2 cases showing carcinomatous growth well after the expiration of the five-year limit, and while the metastatic character of the glands in the second case is not wholly clear, it is all but certain that in each instance we are dealing with but the one disease and not with the development of a second independent growth.

It would be of extreme interest to know the actual outcome in all of our cancer operations today. There is reason to believe that many cases now classed as cured, on the basis of five years' freedom from disease, ultimately succumb to recurrence of the

original growth; our statistics as to cure would probably not be improved by following this matter in detail.

SUMMARY

The basis of this study is 129 cases of cancer of the colon, exclusive of the rectum, which applied for treatment during the years 1889 to 1919. At the time of admission only a little over one-half of them presented a history of partial intestinal obstruction. Forty per cent of the cases had shown no symptoms of obstruction, 40 per cent had a definite history of chronic obstruction, and 20 per cent were admitted in acute obstruction or had previously survived such an attack. The history of partial obstruction, when given, extended over the better part of a year before admission for treatment; those lacking this feature presented other symptoms which had been recognized by the patient for a period of comparable length. Resection produced a five-year cure in 10 per cent of all the cases admitted and in 28 per cent of those surviving resection. Examination of the tissue removed disclosed but 1 case with metastasis to the lymphatic glands, and this case was lost sight of six and a half years after operation; inasmuch as 25 per cent of the recurrences appear after the end of the fifth year it is reasonable to assume that this patient died of recurrence, in which event there is no evidence in this series to show that cancer of the colon is curable by operation after metastasis to lymphatic glands has occurred. There is reason to believe that if a case is curable by surgical means this result will be achieved just as surely by local excision of the growth-bearing portion of the gut as by an operation of much greater extent; from the standpoint of cure, therefore, limited resection which definitely clears the growth appears to meet the situation, but the arrangement of the circulation of the colon is such that one may be forced to make a much more extensive resection in order to be assured of the viability of the remaining tissues. Only a small proportion of these cases are now coming to operation at a time when surgery can cure;

practically all of them, however, have had definite trouble for months, frequently more than a year. Great benefit would no doubt result from a deliberate educational effort directed toward reducing the period of time which at present intervenes between the first appearance of symptoms and the final decision for operation. Apparently a decided improvement in our cure ratio can be brought about in no other way.

DISCUSSION

Dr. Charles H. Peck, New York:

I have been very much interested in this paper, because it deals with one of the most encouraging groups of malignant disease of the internal organs we have to meet.

I have looked over some of our records and find of my personal cases there were 11 living and free from recurrence since 1909, 1 of them done in 1909 for quite an advanced carcinoma of the descending colon with obstruction, a one-stage operation, is still alive and well. I have also several other cases among them, 2 done in 1911, 1 in 1913 and 1 in 1915. One of the 1911 cases I followed for four years (she was perfectly well up to that time, but has been lost track of since), the other is alive and well today.

One of the cases was quite remarkable. A man, aged seventy-five years, with a large carcinoma of the splenic flexure had been operated upon by my colleague, Dr. Dowd, nineteen years previously, for carcinoma of the sigmoid, making a good recovery. Nineteen years later he developed a second carcinoma, which was apparently an independent growth at the splenic flexure. I removed it by the Mikulicz two-stage method. He is now perfectly well, traveling in Europe, eleven months after the second operation.

I am favoring more and more the two-stage Mikulicz operation for growths in the descending colon and sigmoid.

I believe this is an encouraging group compared with carcinoma of the rectum, of the stomach and many other portions of the body.

Dr. Howard Lilienthal, New York:

Dr. Peck has mentioned the important matter of the recurrence of carcinoma of the colon, and this brings to my mind 2 cases in which I operated. The first, a man, lived seven years after resection of a tumor of the hepatic flexure, then died of a carcinoma in the lower sigmoid. The other patient lived for nineteen years and then neglected a second carcinoma in the sigmoid region, from which he finally died.

Dr. A. MacLaren, St. Paul:

I believe that Dr. Lilienthal is correct. New growths do occur, and I mention a case that was operated upon by Dr. W. J. Mayo ten years ago for carcinoma of the rectum, for the purpose of putting it

on record. In this case the bowel was twisted at the original operation and there was the most satisfactory sacral anus that I have ever seen. At the end of ten years this woman developed a tumor in the mid-abdomen which on exploration proved to be an obstructing carcinoma of the transverse colon. It was fairly movable, had no evident connection with the old trouble in the rectum and no glandular involvement. This woman had heart trouble, so local anesthesia was given, which worked beautifully. The only complaint she made of any discomfort was when exploring the liver, where I touched something which I thought was a recurrence in the liver. My assistant examined what I called a recurrence and pronounced it a gallstone, in size as big as an egg. We also found this stone on our *x*-ray plates. The gallstone was not removed, but we did a resection of the colon, and at the end of the week she was very comfortable and doing well.

Dr. Willy Meyer, New York:

In this connection I should like to mention a case upon which I operated fifteen years ago for cancer of the hepatic flexure. I did the operation in two stages, first doing a colostomy and two weeks later the resection. The patient was perfectly well afterward. About five or six years later hematuria developed and the cystoscope revealed the presence of a sessile tumor of the bladder. This was operated upon and the patient made a good recovery. Pathological diagnosis was cancer of the bladder. I mention this case because it shows that a cancer of the colon can metastasize in other organs than the colon and rectum. The patient referred to was still alive and in good condition last year.

It has been stated that the colonic cancer is one of the least virulent forms. It has been shown that the most benign cancer of the human body, so to speak, is that of the esophagus. At the present time surgeons are not often given the opportunity of doing resection of the esophagus. The pendulum has been swinging to the side of radium, but, to my mind, too far. Very few cures, if any, have been reported. A successful case of resection of the thoracic portion of the esophagus for cancer in an early stage is on record. After ten years the patient is alive and well (Torek). I would plead for giving surgeons interested in this class of cases the opportunity to operate radically oftener than is done at present. Only by frequent personal trying can and will they learn to overcome the dangers and difficulties of resection.

Dr. Miller (in closing):

Dr. Peck is to be distinctly congratulated upon his statistics. It may be true that the figures of other operators of long experience who have had a large number of these cases would compare in the same way.

Dr. Peck's remarks serve to emphasize the character of the series we present, namely, it is a composite series and the larger part of the work has been done by men young in surgery. It does not represent the work of men of long experience. It is more nearly the average result obtained today in cancer of the colon.

With reference to the other point, viz., the simultaneous occurrence of two intestinal cancers, I failed to mention the fact that this series includes 3 cases of probable double cancer of the gastrointestinal tract. How accurately we can distinguish between a case of this kind and a true recurrence after resection I do not know. It is certainly true that the ratio of double cancers is exceedingly low. It is also true that the recurrence of cancer after operative removal is, unfortunately, a relatively frequent thing. If a patient survives the operative removal of a cancer and later dies of cancer, particularly if the second growth is situated in the same general region as the growth originally removed, the presumption is that there has been one malignant tumor which has recurred rather than that the cure of a cancer has been followed by the development of a second independent cancer. As Dr. Finney has suggested, careful study of a series of this sort well repays the effort and may prove of great help. This study has shown that most of these patients have symptoms long before they consult a doctor. If they understood what the symptoms meant they would seek help at an earlier date and our chance of success would be correspondingly greater.

RECURRING HERNIA OF THE DIAPHRAGM

By P. E. TRUESDALE, M.D.
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THREE operations upon the same individual for traumatic hernia of the diaphragm within a period of three years have provided rare opportunities for observation. The subject of this series of mishaps, a boy of five years, was run over by an automobile May 11, 1920. One wheel of a touring car passed over his abdomen, producing a rupture of the diaphragm on the left side. The condition was not discovered until January 24, 1921. To relieve obstruction of the intestine we operated by the transthoracic approach February 23, 1921. This case, with one other of similar origin in a child of three and one-half years, I reported before this society in June, 1921. Dr. O'Connell, of Providence, R. I., reports the condition of his case, the younger child, as well after three years.

The older boy developed acute intestinal obstruction November 30, 1921, nine months after the first operation. Laparotomy revealed a greatly distended colon from the ileocecal valve to a point in the transverse colon which had become fixed in the vicinity of the original tear in the diaphragm. Cecostomy was done and no effort was made to reduce the obstruction. *X*-ray examination then demonstrated the obstruction in the transverse colon. He left the hospital December 11, at which time his bowel movements had become normal. Five weeks later he was readmitted for incomplete intestinal obstruction, the cecostomy acting intermittently as a safety valve. The *x*-ray examination again showed the barium column intercepted

in the transverse colon at a point on the level of the diaphragm. January 27, 1922, the left diaphragm was again exposed by the transthoracic approach. There were about 8 ounces of fluid encapsulated between the base of the lung and the diaphragm.

The lung was partially fixed at its base by bands of adhesions to the parietal pleura. It expanded well with inspiration. At the site of the original tear in the diaphragm was an opening, about 3 cm. in diameter, through which protruded a knuckle of the large bowel, incarcerated by adhesions about the opening. The ring was cut and the bowel reduced without difficulty. It was then noted that the diaphragm external to the opening was comparatively thin. The opening was closed with figure-of-eight sutures of silk. Suspecting a trophic disturbance in the musculature of the diaphragm, we tested its reaction to the faradic current through a secondary induction coil. On the median side of the cicatrix, made by healing of the original tear, the response was prompt and brisk, while to the outer side of the scar and over a wide area the reaction was sluggish until the rim of the diaphragm was approached. Here, both laterally and posteriorly, the contraction, though not strong, was evidently a nerve response. Anteriorly the response to electrical stimulation was scarcely perceptible. The chest was then closed with mass sutures of silkworm-gut. The patient recovered and was discharged February 2, 1922. The variation in irritability from a sharp, strong response on the median side of the scar to a very sluggish reaction on the outer side led us to assume that at the time of the original tear at least one branch of the phrenic nerve as it spreads over the central portion of the diaphragm had been injured, with nerve fiber and muscular waste resulting.

We had good reports concerning the patient's condition until November 30, 1922, ten months after the second operation, when he was admitted again because of abdominal pain and persistent vomiting. While coasting during the previous afternoon he had taken a "belly bumper," whereupon he was seized with cramps and distress in the abdomen. Upon examination there was definite evidence of peristalsis in the left chest as

high as the angle of the scapula. The cecostomy opening had entirely closed. Recurrence of the hernia through the diaphragm was therefore obvious. As a preliminary step the opening into the cecum was reëstablished for immediate relief. Five days later, December 5, the diaphragm was approached by laparotomy. The transverse colon was found to have passed through the diaphragm at the site of the original tear and was held by adhesions about the opening. The patient was in good condition. We had become familiar with his measure of endurance, hence we felt that examination of the diaphragm similar to that made at a previous operation could be carried out with more accurate determinations. Therefore we walled off the stomach, spleen and bowel and drew the diaphragm well down into the operative field. An examination of this entire leaf was made as thoroughly as a reasonable time would permit. The edge of the left lobe of the liver had entered the hernial opening. Having become fixed in this position it was separated and withdrawn with some difficulty. This was sufficient to free the colon, a long loop of which was then drawn down through the opening into the abdominal cavity.

Examination of the diaphragm at the aperture revealed a thick cicatrix forming the inner edge of the ellipse with substantial body to the diaphragm adjacent, while the outer edge of the ellipse was thin and the middle portion of the diaphragm perceptibly meager. Again, this would appear to indicate that trophic disturbances had followed inactivity or injury to the terminal branches of the phrenic nerve and warrant the supposition that, under sudden violent increased pressure within the abdomen, rupture occurred by separation of the thin portion of the diaphragm from the margin of the old cicatrix. On this occasion the opening was closed by interrupted sutures of chromic catgut reinforced by a running stitch of silk. The boy is again apparently well after six months.

Electrical stimulation by the faradic current was applied to various portions of the diaphragm, with the same results as obtained at the previous operation. An immediate sharp

contraction showing normal nerve irritability was found along the course of the phrenic nerve until it reached the cicatrix, which ran almost transverse to the median branch. Further examination revealed not alone a perceptible thinning of the central portion of the diaphragm in this case but a sluggish response to the electrical current over this area, indicative of degeneration in the terminal nerve fibers and motor end-plates in the muscle. Again, as we approached the rim of the diaphragm, contractibility to stimuli was more pronounced but far less vigorous than over the unimpaired phrenic nerve.

The abdomen was then closed and the patient made an uneventful recovery, leaving the hospital on the tenth day.

A review of the events in the above case provides material for a three-point discussion of the subject of recurring traumatic hernia of the diaphragm, dealing first, with the cause of recurrence, based upon a study of the position and nature of the tear in the diaphragm as well as alterations of its innervation and tonicity; secondly, with choice in methods of approaching the diaphragm in order to repair the damage in similar cases; thirdly, with the technic to be employed in affecting a reduction of the displaced viscera and closing the rupture.

It is probable that the line of division in rupture of the diaphragm from external violence more often follows than crosses the nerve fibers and vessels, yet it is conceivable that instantaneous rupture from violence may not parallel the nerves in the direction of the median or lateral lumbocostal arches, but more probably intersects their course and results in injury to the terminal branches of the phrenic sufficient to produce trophic changes in the musculature of the diaphragm with at least a moderate degree of eventration as a consequence. May this not be true of the median branch in particular? The findings in the above case would appear to justify this assumption especially in the light of recurrence of hernia on each occasion after a nine months' period of apparent security and the persistence of a perceptible eventration of the left side of the diaphragm. Incidentally, in this respect, traumatic hernia of the

type here considered differs from congenital hernia, where, owing to a deficiency in the diaphragm itself, the terminal branches of the phrenic nerve remain intact but are merely diverted from their normal relation to each other.

In order to study the effects of disturbed innervation of the diaphragm and its application in the case reported above, Dr. Walter Cannon granted me the privilege of conducting a few experiments with the assistance of Dr. Alexander Forbes in the department of physiology of the Harvard Medical School. The first experiment consisted in producing an opening, 10 cm. long, in the diaphragm of a dog, under morphine and ether anesthesia. The line selected was about 5 cm. to the left of the esophageal opening and in an oblique anteroposterior direction. The result of this opening was a definite crippling of the diaphragm. Single make-and-break shocks then applied over different parts of the diaphragm produced a sharp reaction over the area of the median side of the artificial opening, while the same test resulted in a less vigorous response over the nerve fibers on the outer side of the tear and a perceptible slowing down of the response of the musculature in the central part of the diaphragm. The second experiment was carried out upon the diaphragm of a cat in which one year previously the upper root of the phrenic nerve had been cut. By laparotomy both sides of the diaphragm were explored with stimulating electrodes. By using single-break shocks the contractions in response to stimuli appeared to be normal or nearly so over the entire diaphragm. The abdomen was then closed and a dissection of the left side of the neck was made. Both roots of the left phrenic nerve were cut. The wound was then closed. Ten days later the diaphragm was again exposed by laparotomy. Spontaneous contraction was seen in the right diaphragm but none in the left. The left side was visibly flabby as compared with the right and showed a tendency to rise when the right diaphragm contracted, a phenomenon which no doubt would be greatly increased with the abdomen closed. At first exploration with the stimulating electrodes, by using single make-and-break shocks, seemed to

show a brisk response in the central part of the right leaf and only small twitches in the same part of the left. Later the central part of the left side showed fairly good contraction, but nowhere comparable to the response obtained on the right diaphragm. In the ventral area there was much less contraction on the left side than on the right. About the rim of the diaphragm there were good contractions on both sides. The whole diaphragm was removed, put in Zenker's solution and sent to Dr. Stanley Cobb in the department of neuropathology at the Harvard Medical School. Stained sections from the right leaf showed normal structural conditions, while in the left diaphragm, from which the phrenic nerve had been severed for ten days, evidence of active changes was present in the form of early connective-tissue proliferation. The nuclei of the connective-tissue cells were larger, more numerous and less deeply stained.

The muscle striation had not disappeared but there was evidence of this alteration in its incipiency. The silver stain used to determine the condition of the motor end-plates failed us because we had preserved the tissue in Zenker's solution instead of formalin.

Therefore, the evidence thus far accumulated has served the purpose of demonstrating trophic changes in the diaphragm following nerve trauma similar to those occurring in other muscle structures following injury to the nerve supply.

As a result of this change, we have seen a loss in tonicity of the muscle body of the diaphragm, with a moderate degree of eventration and a probable susceptibility to recurrence of hernia after sudden increase of pressure within the abdomen.

Innervation of the Diaphragm. In order to understand the alterations possible in the musculature and function of the diaphragm from injury to its nerve supply by trauma, it is necessary to know the source and distribution of the nerves which enter this important partition. By far the most important nerve to the diaphragm is the phrenic, which has its origin from the fourth cervical nerve reinforced by small roots from the third and fifth. In a dissection of these nerve roots in the cat

we found only two cervical roots. Neuhöfer[1] has demonstrated that to these nerves are attached the sympathetic fibers from the lower ganglia of the neck. Below, the phrenic nerve pursues an anterolateral course and pierces the diaphragm at the junction between the musculature and the central tendon. Under cover of the peritoneum it splits into three branches, a lateral, anterior and posterior. The rim of the diaphragm is supplied by the lower intercostal nerves. Meckel[2] described these motor nerves in 1817 and Joseph Swan[3] wrote at length on this innervation in 1830. Hence this motor intercostal innervation is pretty well established. Ramström[4] goes further and says: "The intercostals send not only motor but sensory nerves to the rim of the diaphragm. The serous covering of the diaphragm in its central part is supplied by the sympathetic and phrenic while the five lowest intercostal nerves supply its peripheral part."

Felix,[5] in his experimental work, demonstrated very fine branches from the phrenic nerve going into the peritoneum as well as into the pleura of the diaphragm. These serous endings of the phrenic nerve lie, with very few exceptions, in the central part of the diaphragm and again in the lumbar part of this region. Felix also demonstrated that almost all the phrenic branches which have sensory endings in the serous covering of the diaphragm are associated with the sympathetic. He believes it possible that the sympathetic controls some of the musculature of the diaphragm. Furthermore, he points out the well-recognized clinical fact that irritation of phrenic nerve-endings produces pain in the region of the shoulder, as observed in subdiaphragmatic abscess. In addition, Luschka[6] has shown that irritation of the intercostal nerves to the diaphragm produces pain in the epigastrium. Under these circumstances there must be a zone in the diaphragm which when irritated will produce pain that is local and pain that is referred also to the shoulder. Gerhardt[7] found in 4 cases of diaphragmatic pleuritis abdominal pain as well as shoulder pain. He referred the former solely to the intercostal nerves.

Mechanism of Rupture. With these anatomical facts before us the events associated with rupture of the diaphragm are more easily understood, though curious and engaging. Immediately following a rent in the diaphragm there is a tendency for the pressure in the pleural and peritoneal cavities to equalize. The normal negative pressure in the thorax approaches the positive pressure of the abdominal cavity. Upon inspiration, contraction of the normal side of the diaphragm increases the pressure within the abdominal cavity, thereby pushing the swinging abdominal viscera into the opening through the ruptured leaf of the diaphragm. Here the viscera are helped along in the upward direction by suction from the expanding thorax above. Thus a double force immediately comes into play, resulting in a transposition of the loose abdominal viscera. As much passes through the aperture from below as the size of its lumen permits. The lung on the affected side expands in proportion to the free space in the thoracic cage and the degree of obstruction in the hernial orifice. For example, at the first operation we found the left chest cavity filled with coils of intestine and the lung on the same side in a state of complete collapse. During the second operation the aperture in the diaphragm was small and completely closed by a knuckle of intestine. Here the lung was expanding to the limit of space allowed above the small amount of excysted fluid over the diaphragm. The motion of the crippled diaphragm was observed to be limited always. Its relative position was high when only an angle of gut closed the opening, perhaps normal or readily accessible from below when a long loop of the colon had passed into the thorax and completely fallen when a large mass of obstructed and dilated gut occupied the entire thoracic cage. Under the latter circumstances the injured leaf of the diaphragm was forced into a state similar to that of the abdominal wall in the presence of intestinal obstruction. Therefore, it is obvious that many factors come into play, making the clinical picture of traumatic hernia of the diaphragm varied and of compelling interest.

Methods of Approach. The different methods employed in approaching the diaphragm in our cases afforded an opportunity for comparison under conditions that in many respects were similar. We learned at the first operation that reduction of a considerable length of incarcerated gut through the diaphragmatic opening by means of thoracotomy would be exceedingly difficult, if not impossible, unless the diaphragm was elevated to a considerable height by a finger hooked under the margin of the ring, thus creating a vacuum in the abdominal cavity; that adhesions within the thoracic cage are more easily dealt with by means of an intercostal approach; and that laparotomy in the absence of adhesions above the diaphragm is an equally good approach, especially if the patient is a child. It is a less disquieting means of access because it is a more familiar operation to the average surgeon. Hence the choice of method in approaching the diaphragm is more often an individual problem. The surgeon will do wisely to select the method which best fits into his own scheme of things.

The method of closing the opening in the diaphragm has varied considerably in the hands of different surgeons, owing to individual preferences and to the great variety in the types of hernia. Scudder[8] denuded the edges of the opening and closed with mattress sutures of silk.

Mathews[9] employed mattress sutures of chromic gut to close the orifice in the diaphragm and anchored the stomach to the suture line of the abdominal incision.

Arthur D. Bevan[10] closed the opening in the diaphragm with interrupted sutures of Pagenstecher linen. In 2 cases where a hernial sac existed he closed the opening of the invaginated sac with catgut, but in each case exercised the precaution of anchoring the stomach to the diaphragm or to the parietal peritoneum.

James F. Mitchell[11] closed the opening with catgut. His suture line was so near the chest wall that he anchored it there with mattress sutures.

Balfour[12] closed the opening with a double strand of chromic catgut.

In the first operation we closed the tear in the diaphragm with a running suture of cumol catgut, reinforced by three sutures of the same material. At the second operation we enlarged the opening, denuded the edges, then closed with catgut and interrupted sutures of silk. In the last instance we prepared the aperture in the same manner and closed with interrupted sutures of silk reinforced by chromic catgut.

SUMMARY. 1. Rupture of the diaphragm as a result of external violence is seldom mentioned in medical literature, though as an undiscovered cause of accidental death it may not be rare.

2. Deficiency in the musculature of the diaphragm exists as a natural sequence of prolonged limitation of function or of trauma to terminal branches of the phrenic nerve or of both of these conditions.

3. Recurrence of hernia of the diaphragm after many months is a liability irrespective of the method or suture material employed in repair of the hernial orifice.

4. The method of approach in dealing with hernia of the diaphragm may be selected to best advantage after determining the direction of greater accessibility and conditions to be met above and below the diaphragm.

5. Early operation and the avoidance of such activities as produce unusual increase of intra-abdominal pressure are the only safeguards against recurrence.

REFERENCES

1. Mitteilungen a. d. Grenzgeb. der Medizin und Chir., 1922, xxxv, 1.
2. Handbuch der Menschlichen Anatomie, Berlin, 1817.
3. A Demonstration of the Nerves of the Human Body, London, 1830, p. 29.
4. Mitteilungen. a. d. Grenzgeb. der Med. u. Chir., 1906, xv, 642.
5. Deutsch. Ztschr. f. Chir., 1922, 171.
6. Nervus Phrenicus, Tübingen, 1853.
7. Die Pleuraerkrankungen, Stuttgart, 1892.
8. Trans. Am. Surg. Assn., vol. xxx, p. 428.
9. Trans. Am. Surg. Assn., xxxviii, 620.
10. Arch. of Surg., No. 1, i, 23.
11. Trans. Am. Surg. Assn., xxxviii, 263.
12. Trans. Am. Surg. Assn., 1920, xxxviii, 624.

EVENTRATION OF THE DIAPHRAGM: TWO CASES SHOWING SYMPTOMS CALLING FOR SURGICAL CONSULTATION

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I PRESENT 2 cases of a rare anatomical anomaly that offered interesting problems in diagnosis, that in one instance led to an operation that we believe was uncalled for, and in the other instance made us hesitate to operate because of the anomaly and spared the child an unnecessary operation.

Both children present the same findings. There is a high-lying diaphragm on the left side, with the stomach, spleen and large bowel occupying the space usually filled by the lung. The heart is in the right chest. The stomach is large. The large bowel is also dilated and enlarged. The liver is vertical and right-sided. The chest wall shows a slight bulging of the lower half of the left side. This condition was designated as eventration of the diaphragm by Cruveilhier.

The first case, E. K., (St. Louis Children's Hospital, No. 16368, December 30, 1920) had been operated upon six months before admission to the hospital, at the age of fourteen months, when a part of the eighth rib on the left side was resected and a tube introduced. At that time the child had had influenza and bronchopneumonia followed by what was considered to be empyema. The drain had remained in place six months, and a week after it was removed an abscess formed along the tract forward of the fifth rib. At this time the child was brought

FIG. 1.—Case I. At time of admission. Eventration of diaphragm which we thought to be a hernia. Valve-like projection from the median shadow of the stomach, which simulated the diaphragm. Case had been operated six months before for supposed empyema. Note right-sided position of the heart.

to the hospital because the fever had been high, the thirst violent, and it had vomited everything for three days. The baby cried continuously for water, which it drank ravenously, only to vomit it immediately. The child's condition was pitiful. It was wasted, extremely restless and temperature elevated. Water was given by the rectum, sodium bicarbonate and glucose intravenously and saline intraperitoneally. After twenty-four hours the anhydremia was relieved and feeding was started through an in-lying duodenal tube. The sinus through the resected rib led into a small cavity, which was an extrapleural abscess, and outside the fifth rib there was another abscess of the chest wall which extended forward. Except for noting that the heart was displaced to the right, the physical examination of the chest was unsatisfactory. The *x*-ray showed what we thought was a diaphragmatic hernia with part of the stomach in the chest. There was no obstruction to the esophagus. A clear gas-filled area was seen bounded above by a clean-cut curved line and below by a horizontal fluid level. On shifting the child's body the fluid flowed into the clear space in the chest, so that when the patient was inverted the chest was filled with fluid, except for a small area above the rounded dome of the stomach, which was occupied by the lung. The stomach was apparently divided into two compartments.

At first we thought that at the time the operation was performed for supposed empyema, six months before, the diaphragm had been opened near the costal attachments and the stomach had worked its way through. This opinion was later revised when we fortunately got the plate taken before the first operation, which shows the small lung space on the left, and lying beneath the intact diaphragm, a clear gas-filled space which evidently represents the stomach just as is shown by our latest *x*-ray views of the child, now well. We are of the opinion that the condition at present represents what was present before operation and is a typical eventration of the diaphragm with the stomach of regular outline and the top of it covered by the very high-lying diaphragm. The child was treated expectantly, the

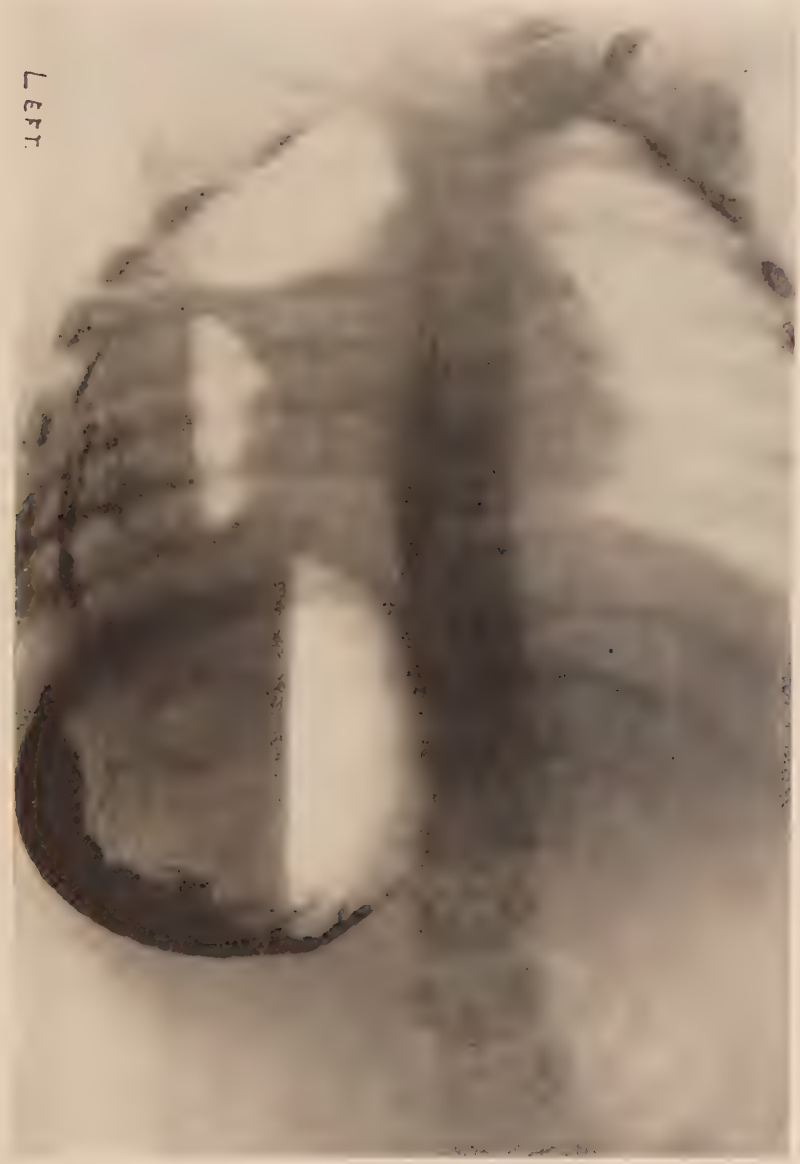

FIG. 2.—Case I. Taken with child on the side. Different levels of fluid in stomach due to air trapped in upper compartment by valve-like projection of stomach wall. Such a condition as might be seen in hernia, but intact diaphragm is seen above top of upper end of stomach.

superficial infection cleared up and the sinuses closed. The stomach, relieved of the surrounding inflammation, began to function correctly and the child is now perfectly well. At the first operation either the stomach was perforated after opening the chest wall or the incision had led into the peritoneal cavity.

The second case, R. D. (St. Louis Children's Hospital No. 19145–M, August 3, 1922), is a boy, aged six years, who had first been studied because of malnutrition. On examination the heart was found in the right chest and in the left chest tympany extended up to the third rib in front and down to the level of the twelfth rib. A succussion sound was demonstrated over the tympany, and in the upright position a line of dulness was made out below, which disappeared when the child lay down, and this was considered stomach and not an encapsulated pyopneumothorax. The *x*-ray examination showed an atypical high diaphragm rising to the level of the second intercostal space and below this the stomach, with the esophagus entering opposite the eighth vertebra. The colon also reached to the level of the diaphragm, but was displaced when the stomach was full. The spleen, normal in size, was seen hugging the lateral costal wall. The liver, of normal size, was entirely right-sided and extended to the crest of the ilium. The heart was in the right thorax. The child was discharged, under instructions as to diet, and gained in weight and strength.

Four months later he was brought back because of an attack of abdominal pain which simulated appendicitis. In the afternoon he had severe epigastric pain which moved later to the lower abdomen. There was general abdominal tenderness and nausea, but no vomiting. When he entered the hospital, a few hours later, he had a temperature of 101°, leukocytosis of 17,400, with abdominal pain; but there was no consistent point of tenderness. At times he was more tender in the right lower quadrant and then over a corresponding point on the left side. After a very large spontaneous stool the child felt quite comfortable. Examination of the rectum showed it to be very

FIG. 3.—Case I. Two years after Figs. 1 and 2. Child inverted. Bismuth in stomach shows outline of intact diaphragm; valve-like projection in stomach wall has disappeared.

large. The external sphincter was very weak or absent, but the internal sphincter was tight. In this case, as in the previous one, the large bowel was generally dilated and redundant, as shown in the *x*-ray. We concluded that he had the cramping and pain occasionally seen with these large bowel distentions, and we deferred operation. The temperature was explained by a reddened throat. The next day the boy seemed well. After another study with the *x*-ray the boy went home.

Under usual conditions neither child presents any untoward symptoms from their anatomical anomalies.

Cruveilhier, in 1849, credits J. L. Petit with having described this condition found at autopsy in which the diaphragm on the left side was distended, forming a high-lying flask-shaped pouch. There was no rupture of its membrane and the diaphragm was considered to have lost its power of contraction. The stomach, colon, omentum and spleen occupied the space usually filled by the left lung. The heart was in the right chest. Others have since described the condition and there has been much discussion of the name. Wieting[2] gave the name "relaxatio diaphragmatis" and Königer[3] "idiopathic high-lying diaphragm."

The condition is rare. When we compare these cases with hernias of the diaphragm we find, according to Struppler,[4] there are 44 eventrations to 500 hernias of the diaphragm. Before the *x*-ray there were few cases diagnosed. Up to 1899, Newmann[5] found only 8 cases in the literature, and these were discovered accidentally at autopsy; since that time up to 1919, 41 cases have been reported, of which 19 have been confirmed by autopsy.

The condition is probably congenital in origin, at least it has been observed in very young children. There is a theory that is held by some that the diaphragm is paralyzed, due to the atrophy of the phrenic nerve; but in 7 cases in which the nerve was examined only 4 showed a decided change of this structure. (Neumann.) In both of our cases the diaphragm went through a typical excursion in the fluoroscopical examination, which differed from the opposite side only in being much

FIG. 4.—Case II. Showing intact diaphragm on left side, with stomach, large bowel and spleen lying below. Heart almost entirely right-sided. Liver vertical. Large bowel is redundant.

more restricted. In many of the cases studied at autopsy the diaphragm showed thinning and replacement of muscle tissue with fat.

Eventration occurs nearly always on the left side. In those cases in which the autopsy reports mention it the lung is small, but has two lobes.

This condition may exist without giving any symptoms and advanced age may be reached without any evidence of trouble. Symptoms if present may be referred either to the chest or to the abdomen. Some cases have complained of discomfort in the left chest or have had a sense of pressure. Very rarely has there been any complaint of the heart which is pushed far to the right. Dyspnea is often noted with inflammation of the left lung and distress follows coughing, as in bronchitis. Frequently there are digestive disorders, with distress after eating. Occasionally the kinking of the lower end of the esophagus gives symptoms similar to cancer of the esophagus. The stomach, which is larger than usual, may be the seat of hemorrhages, or volvulus may develop. The large intestine may be dilated and symptoms may arise similar to those in Hirschsprung's disease.

In making the diagnosis it is most important to consider the variations shown by percussion and auscultation. The heart is found in the right side of the chest. A large part of the left chest is tympanitic and there is a dulness which varies with position of the body and with taking of food and liquid. This shifting dulness of the partly filled stomach may be mistaken for pyopneumothorax, as in one of our cases. Succussion if obtained must be located in the pleura or stomach and the diagnosis cleared by the *x*-ray.

The chief confusion in diagnosis will be with diaphragmatic hernia. As both conditions may be congenital and both exist for a long time without manifest symptoms, it is often impossible to distinguish between the two conditions without a thorough *x*-ray study. The continuity of the arch of the diaphragm in eventration or displacement marks the distinction between hernia, which, whether congenital or traumatic in origin, shows

FIG. 5.—Case II. Showing particularly well the rounded intact dome of the left diaphragm, the large stomach and the vertical liver.

FIG. 6.—Case II. Lateral view to show the diaphragm intact and its very high position.

an irregularity in the diaphragm, and the mottled appearance of the lung may show through the gas contained in the stomach.

In a fluoroscopical examination the diaphragm moves with respiration, or the excursion may be much reduced, due to congenital hypoplasia of the left lung. In diaphragmatic hernia a "paradoxical expiratory displacement" has been noted; with forced inspiration the herniated diaphragm ascends, and descends with expiration.

The displacement of the heart may confuse eventration with situs transversus, but further examination will show the liver to be right-sided and the stomach on the left.

The prognosis in cases of eventration is good and death has never been observed as a direct consequence of the condition. Complications arise from the involvement of the organs that enter into the abnormal displacement, but are rarely more serious than are seen with normally placed viscera.

Nothing much need be said about treatment, as what there is should be entirely symptomatic. Eventration is not an operable deformity, in contradistinction to diaphragmatic hernia, which most often is. But eventration has been operated upon because of a diagnosis mistaking it for pyopneumothorax, as in our first case, and as in a case reported by McNab.

For the prevention of serious complications, severe exertion should be avoided.

Bibliography

1. Cruveilhier: Traité d'Anatomie Pathologique, 1849, tome i, p. 617.
2. Wieting: Ueber die Herniæ diaphragm, Deutsch. Zeit. f. Chir., 1906, lxxxii.
3. Königer: Zur differential diagnose der Zwerchfellhernia und die einzeitigen iodopathisher Zwerchfellhochstandes, München. med. Wchnschr., 1909, vi.
4. Struppler: Ueber den physik. Befund und die neueren klin. Hilfsmittel bei der Diagnose Zwerchfellhernie, Deutsch. Arch. f. klin. Med., 1901, lxx.
5. Neumann: Zur frage der Relaxatio Diaphragmatica, Deutsch. med. Wchnschr., 1919.
6. Bergmann: Ueber Relaxatio diaphragmatica (eventratio diaphragmatica), Ergeb. d. inn. Med. u. Kinderheilk., 1913, xii.

DISCUSSION ON THE PAPERS OF DRS. TRUESDALE AND CLOPTON

Dr. Howard Lilienthal, New York:

I have been very much interested in this subject, especially the traumatic hernias, and I want to point out a very valuable method of studying these cases which I have employed.

I refer to pneumoperitoneum. The first case of diaphragmatic hernia in which I used the method was that of a man who was struck on the left side by a wagon-shaft. You will recall that most of these hernias are on the left side, because the liver, being on the right, acts as a protection. He came into the hospital with what was recognized as an abdominothoracic injury. After having been in the hospital for three weeks he was about to return home because he felt nearly well. As he was about to leave the hospital he said that he had indigestion, which he had not had before. It was my house surgeon, Dr. Joseph Somberg, who suggested that I have an *x*-ray study made. I found that the stomach, with other viscera, was displaced and in the thorax. I then operated, making a wide intercostal incision. The abdominal viscera were adherent to his pleura, but I mobilized the organs and returned them to the abdomen. This was one and a half years ago and the patient has remained well.

The other was a case of congenital eventration of the diaphragm in a young man who had had attacks of what was thought to be appendicitis. Diagnosis was made by roentgenography.

I agree with Dr. Clopton that these cases should be treated symptomatically. Necessity will arise when the patient has repeated attacks resembling intestinal obstruction.

As to the avenue of approach, I think much depends on when the patient presents himself for treatment. In early recognized cases the transperitoneal route may be employed, but later adhesions may forbid traction from below. Another danger is that when ribs have been fractured their sharp points may lacerate the prolapsed viscera when traction is made.

The first requisite is a wide intercostal incision with exposure by a rib spreader. Follow this by a laparotomy if necessary.

The matter of pneumoperitoneum is something which I wish to emphasize. It is of the greatest importance in the differential diagnosis of true hernia with a sac or a prolapse through a wound in the diaphragm.

Dr. Carl Davis, Chicago:

In further discussion of the papers of Drs. Truesdale and Clopton, I would like to report a case of diaphragmatic hernia in which an unusual method of closure was involved.

The patient had been showing increasing distress for a year. She had been handled under the diagnosis of pyloric obstruction. There was a marked loss of weight and strength. Finally the diagnosis was made by means of the *x*-ray.

After the hernia had been exposed the patient suddenly went into shock. It did not seem advisable to prolong the operative procedure any more than was absolutely necessary. The omentum was resected and tucked into the diaphragmatic opening and held in place with a couple of sutures.

The patient was able to eat a normal meal before leaving the hospital. Apparently the stomach had been held below the diaphragm by the obturating mass of omentum.

Dr. Le Wald, New York (by invitation):

Dr. Truesdale, knowing of several cases of hernia of the diaphragm which I have studied roentgenologically, has asked me to show lantern slides of these cases. The subject is of great interest from the pathological standpoint, particularly in view of the large number of cases of hernia of the diaphragm which are of congenital origin. The subject is also of interest on account of the confusion between eventration and hernia of the diaphragm. The association of some intercurrent lesion, such as gastric or duodenal ulcer, in a case of hernia or eventration of the diaphragm, adds considerable difficulty to the diagnosis. I have been informed by Dr. Carman of a case of this sort which has been recently encountered at the Mayo Clinic.

In one of the cases which I shall illustrate there was a duodenal ulcer associated with the presence of an extreme degree of eventration of the diaphragm, the diagnosis being confirmed at operation by Dr. W. A. Downes. In another case operated upon by Dr. Downes there was a congenital abnormality present which is best described as thoracic stomach. This condition was described by Percival Bailey in the *Anatomical Record*, October 20, 1919. Bailey encountered his case in the anatomical laboratory of Northwestern University Medical School in a subject seventy-seven years of age.

The question of deciding whether a particular case of hernia of the diaphragm is of congenital or traumatic origin is a very important one, especially in view of a recent decision in the New York State Supreme Court. In this case a child was struck by an auto-

mobile and was found on *x*-ray examination to have a hernia of the diaphragm. On account of this a suit for $75,000 was instituted. At the trial I was able to furnish evidence sufficient to convince the jury that the case in question was one of *congenital* hernia of the diaphragm, and a verdict in accordance with this was brought in by the jury.

In 5 other cases we have observed congenital hernia of the diaphragm. One of these cases is of particular interest because of apparent absence of the left side of the diaphragm, as determined by lateral radiographic examination. Dr. Lilienthal has been greatly interested in this case and has suggested that an artificial pneumoperitoneum would be advisable in order to study the defect in the diaphragm. I have hesitated to do this in view of the absence of any definite hernial sac and the consequent danger of collapsing the left lung, as there appears to be a direct communication between the peritoneal and pleural cavities on the left side.

On encountering a case of hernia of the diaphragm I think it advisable to consider the case as of *congenital* origin unless it can be conclusively proved to the contrary. One author has gone so far as to state that, in his opinion, the only positive evidence of traumatic origin is to be obtained by removing a section of a portion of the margin of the hernial ring at operation, and on microscopic examination finding no endothelial structures in the region of the supposed rent in the diaphragm.

Dr. Truesdale (in closing):

Dr. Clopton's paper and this discussion have been very illuminating. I gather from Dr. Clopton's observations that there are a number of different factors which enter into the causation of eventration of the diaphragm, such as defective innervation, defects in the musculature of the diaphragm and defects in the development of the diaphragm. If there is a congenital defect in the nerve supply there may have been a normal musculature in the diaphragm in the fetus, but an insufficient nerve supply inevitably would result in loss of muscle tissue. Therefore, eventration may be due primarily and entirely to defective innervation.

There are a great many oddities about this condition of eventration and also about hernia of the diaphragm. As a rule, there is great difficulty in making a diagnosis. In some of the cases that were shown it was stated by the examiner that there was fluid in the chest. One case has been reported in which the examiner made the diagnosis of free fluid in the chest and believed it was of simple origin.

The child had been fed a short time before. The examiner introduced a trocar. He got milk and promptly realized that the stomach was in the pleural cavity.

The difference between eventration and hernia of the diaphragm, particularly in children, is often difficult to determine. In fact, this cannot be done without the aid of the roentgenologist. If one's patient is unfortunate enough to have a recurrence it can be repaired with perfect safety. It is remarkable how well young children bear this operation if it is done with reasonable rapidity either by the thoracic approach or by the abdominal route. At the first operation upon the case which I have reported today, I went through the chest wall because the hernia had been in existence for nine months and it seemed very likely that there would be adhesions and other complications. In the last instance I operated by laparotomy, because the obstruction was only five days old.

NOTES ON THE ADVANTAGES, DISADVANTAGES AND METHODS IN THE MANY-STAGED OPERATION FOR GOITER

By MARTIN D. TINKER, M.D.
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The management of toxic goiter is still one of our difficult problems after over twenty years' intensive study by many active workers. There is fairly general agreement that surgery offers the most reliable treatment, after extended trial of serums, endocrines, radium, *x*-ray, and a host of other measures. There is also quite general agreement as to the value of dividing the operation into stages, but there are still some fatalities from failure to recognize the gravity of conditions calling for the many-stage operation or the time when even the least intervention can be safely undertaken. Judgment as to how much to do and when to do it still makes the difference between life and death, health or invalidism, in this as in many other fields of surgery.

In a paper entitled "Factors Influencing the Safety of Operation for Goiter," read at the Surgical Section of the American Medical Association meeting at Los Angeles, Calif., June, 1911, I advocated preliminary study and treatment of from a week to a month, followed by operation in stages, in the mangement of doubtful cases. Two types of operation were suggested: First, that beginning with elevation of the flap as for excision, and interrupting the operation and packing the wound at any stage when the patient's condition suggested that it may be unsafe to continue much further; second, the ligation of one or more important

vessels supplying the thyroid gland, as advocated by Kocher, to be followed, as the patient's condition warranted, by further ligation or excision, or possibly by further ligations and repeated partial excisions. These methods still have their place, but further experience has suggested modifications of value, both as concerns safety and permanent results. The most important advantages of these procedures are: (*a*) First of all, greater safety to life; (*b*) the possibility of earlier intervention, thus arresting toxemia before serious permanent damage results to vital organs; (*c*) extending the range of operability by a relatively trivial and safe procedure, making many desperately ill patients fit risks for later curative surgery. The disadvantages are: Slight to considerable extra scarring; added hospitalization and expense; and, as concerns wound-packing in many-stage excision, a slight but none the less definite risk of infection. I have never seen infection of any gravity, but where the patient's serious condition seemed to make it safer to delay closure for several days, occasionally there has been low-grade infection, causing delay in healing and some additional scarring.

The chief advantage of ligation is that, by a relatively simple and safe procedure, taking but a few minutes' time, approximately one-fourth of the blood supply is cut off, theoretically at least, and the activity of the gland reduced to that degree. In actual practice the reduction in gland activity does not always follow, partly because the collateral branches are so numerous and widely distributed that the blood supply is rapidly reëstablished. The number of vessels at the upper pole of the thyroid which we have encountered at the operating table, not usually shown in anatomical reference books, has been so great that my associates and I started several years ago to record them. From a study of 200 consecutive ligations we found that the text-book descriptions of the superior thyroid artery dividing into main anterior and posterior branches is most unusual; that two or three groups of vessels is common; as many as 7 vessels were found in one case; and in another the largest and most active vessel came along the isthmus from the opposite

side. One of the earlier editions of Quain is the only text giving any adequate description of the numerous and irregular sources of blood supply to the superior thyroid pole, which we have found the common rather than the abnormal distribution. It is evident that in order effectually to cut off the blood supply of the superior thyroid pole and get the supposed advantage of ligation there must be fairly free exposure and the entire blood supply secured. Such increased care to secure all the vessels of the superior thyroid pole has not, in my experience, greatly increased the time required for ligation and has not added appreciably to the risk of operation. Lobes removed at later partial thyroidectomy, in a considerable proportion of cases, show clearly the effect of complete cutting off of the blood supply, both microscopically and frequently in the gross. In certain cases there is apparent increase of fibrous tissue with lessened gland cells. In other cases the part of the gland, originally hyperplastic, influenced by ligation takes on the appearance of simple colloid goiter. With widely differing blood supply there are, of course, widely differing results following ligation.

Another important advantage of the many-stage operation, with multiple ligations, is the time required. Certain of these patients will die whatever is done, or if nothing is done; but the majority will recover if sufficient time is taken for rest and preliminary treatment. Goodpasture has shown that there are definite and serious myocardial changes, apparently the result of extreme thyroid toxemia, and it would be unreasonable to expect a heart crippled by myocarditis or dilatation to recover without prolonged rest. The same is doubtless true of damage to the nervous system. The *x*-ray, which is in great favor in the treatment of such cases in certain localities, has seriously aggravated the symptoms in a number of patients who have come under my observation. These patients have later responded well to prolonged preliminary rest and care, followed by ligations, and later, partial excision. If a year or even more devoted to preliminary treatment and modified rest cure, between the various operative stages, will bring such

a patient back to reasonable health and efficiency, it seems a small price to pay out of the twenty-five to forty years' normal expectation of life which many of these patients have. Of course, so long a time is unnecessary except in extreme cases. The time element gives such treatment by ligations and later excisions decided advantages over many-stage excision in such cases, for even if the patient survives excision, extensive operation in the stage of extreme toxemia undoubtedly puts a strain on the heart from which it may never fully recover after ever-so-prolonged postoperative rest. The considerable number of articles on many-stage excision which have appeared during the past two or three years lead me to believe that it is being used in some of the cases of extreme toxemia in which preliminary ligation, preceded and followed by prolonged and modified rest-cure, and later followed by partial excision, would give better permanent results. Having originally advocated this method and used it in suitable cases ever since, I feel justified in criticising its use in cases in which I feel strongly that the more conservative plan would give better permanent results.

Ligation at the lower instead of the upper pole of the thyroid I have not used as a part of the many-stage operation, because of (1) risk of injury to the recurrent nerve; (2) greater difficulty, especially with deeply located, especially intrathoracic or substernal growths, or if there were many extra vessels, as has proved so common at the upper pole; (3) the formation of deep adhesions, making difficult a subsequent partial thyroidectomy, not a fanciful difficulty, as I have discovered in operating upon patients whose lower pole vessels had been ligated elsewhere.

Ligation of all the main thyroid vessels I have not employed, because, as shown many years ago by the fundamental experimental studies of my former chief, Dr. William S. Halsted, at least one pole of the thyroid must be left with unimpaired blood supply if normal function is to be maintained.

In this connection it may not be out of place to mention two little-used criteria in estimating the fitness of extremely toxic patients for any surgery—the differential blood count and the

pulse-deficit chart. These we have found of sufficient value so that we record them along with basal metabolism and pulse-rate. Cabot mentioned the association of lymphocytosis with exophthalmic goiter in an early edition of his book on the blood, and Kocher considered the blood examination of considerable value. While not of as much value as some other data the blood report helps to make up the complete clinical picture, from which we decide what it is best to do or leave undone, and ordinarily it checks up in fair accord with the other clinical tests. A pulse-deficit chart, or some other means of regularly recording the relation of the apex-beat to the pulse, seems to me of far greater value. Any persistent discrepancy between the apex-beat and the radial pulse in a patient who has had fairly prolonged rest, with digitalization and other preliminary treatment, we have considered sufficient evidence of myocardial insufficiency to make even the least of the many-stage procedures too hazardous in practically all cases. To be of value the record should be made by a specially instructed and intelligent nurse or by a doctor. Many untrained pupil nurses do not use a stethoscope well enough to record the heart accurately. When accurately charted it gives at a glance knowledge of first importance. Fortunately the heart condition and deficit chart which records it improve in the majority of cases under suitable preliminary rest and care.

In conclusion, to emphasize a few points in this brief paper which seem to me important: Operation divided into many independent stages not only makes it possible to save the lives of most of these desperately ill patients, but with the many-stage operation it is easier to enforce the rest and care indispensable to ultimate complete recovery, especially in those cases with dilated hearts and myocardial degeneration.

The disadvantages of greater scarring, prolonged hospitalization and increased expense seem trivial when safety and permanent recovery are considered.

The advantages of preliminary ligation will be more fully realized when the pole of the gland is well exposed, so as to

make certain the securing of all vessels, great and small, main and collateral.

Many-stage excision with wound-packing is best reserved for the few cases in which it has proved impossible, by careful preliminary study, correctly to estimate the gravity of the patient's condition, and unexpected grave symptoms develop during operation. In such cases it saves life, and the disadvantages of slight risk of infection and additional scarring scarcely deserve consideration.

SURGERY OF THE THYROID AND ITS MORTALITY

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AND

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(By Invitation.)

During the last sixteen months, to May 1, 1923, 2524 operations were performed on 1949 patients with goiter: 25 died, a mortality by operation of 0.99 per cent, and by case of 1.28 per cent. Unless accurately classified according to the presence or absence of hyperthyroidism, these percentages have no special significance, for an adequate appreciation of the mortality from surgery of the thyroid gland is dependent on the understanding of the operative dangers incident to the various types of goiter.

According to the dangers attending surgery, all lesions of the thyroid may be classified into two groups: Goiters unassociated with hyperthyroidism, and goiters associated with hyperthyroidism. The operative risks in the two groups are not comparable. In the former, the dangers are confined to the accidental causes to which any operation of equal magnitude is subject, while in the latter the greatest danger lies in the disease itself or the residual effects of the disease. For instance, the technically successful operation may precipitate or be followed by an acute exacerbation of hyperthyroidism, from which the patient does not recover. It is obvious, then, that the mortality rate in "goiter surgery" is decidedly influenced by the proportion of goiters without hyperthyroidism included in the computation.

The goiters unassociated with hyperthyroidism, and which are amenable to operation, include adenomatous goiters, malignant goiters, thyroiditis and occasionally the colloid goiter. As

the health of the patient is unaffected by the goiter, the dangers involved in its removal are limited to operative and postoperative accidents, which include hemorrhage, pulmonary infections, obstructive dyspnea, tetany, air embolism, pulmonary embolism, infections and intercurrent diseases.

With the development of the standardized operation and care in the details of operation, technical errors have been reduced to a minimum. In the Clinic the incidence of postoperative obstructive dyspnea and pneumonia have been materially decreased since it has been appreciated that both are at least partially avoidable. In the past the causes of postoperative obstructive dyspnea were believed to be confined to collapse of the trachea and edema of the glottis, both unavoidable complications, but in recent years a clearer recognition of the important part played by the injury of the recurrent laryngeal nerve has led the surgeon to exercise more care in its avoidance; in consequence, postoperative obstructive dyspnea has been practically eliminated as a danger in goiter operations. Likewise the incidence of postoperative pulmonary infections has been materially reduced by the avoidance of prolonged anesthesia and of injury to the recurrent laryngeal nerve.

Intercurrent diseases, such as diabetes, influenza and thrombosis, are unavoidable complications, but must be considered if, as is the practice in the Clinic, the mortality-rate is to be computed from all patients who die in the hospital without regard to the cause of death or the length of time after operation.

In the last sixteen months 819 thyroidectomies were performed on 819 patients: 3 patients died, a mortality of 0.36 per cent.

The goiters associated with hyperthyroidism include exophthalmic goiter and adenomatous goiter with hyperthyroidism. The development of acute hyperthyroidism and the presence of visceral degenerative changes comprise the added dangers to surgery in both types; but as the relative importance of these dangers varies in the two types and as preoperative measures are not comparable in efficiency it is desirable to discuss the surgical problems of the two diseases separately.

Exophthalmic Goiter. Visceral degeneration in patients with exophthalmic goiter, due to the long-continued hyperthyroidism, was formerly the most important cause of the high operative mortality. But in recent years, owing to the wider dissemination of the benefits derived from surgery, a larger proportion of patients with exophthalmic goiter are coming to surgery earlier in the course of the disease and before the development of visceral changes. This is illustrated in a forceful manner by a comparison of the data for different periods relative to the duration of hyperthyroidism. In 1909, the average duration of hyperthyroidism in the series of patients with exophthalmic goiter was thirty-one months; in 1916, twenty-three months, and for the first six months of 1922, nineteen months. This fact has influenced not only the reduction of the operative mortality, but the improvement in the end-results.

Our means of combating the postoperative reaction of hyperthyroidism or dysthyroidism, when once induced, are ineffectual. The mode of attack lies rather in prevention. Through the coöperative efforts of the internist, the laboratory workers and the surgeon, great improvement in the preoperative preparation of these patients has been accomplished, so that today the occurrence of postoperative reactions has been reduced to a minimum.

The preoperative preparation consists of medical and surgical measures. About 30 per cent of the patients, on admission to the Clinic, have only a mild degree of hyperthyroidism, and as their general health is unimpaired, preliminary treatment other than routine preparation is unnecessary. Preliminary treatment is indicated in the other 70 per cent of patients on account of the intensity of the hyperthyroidism or the patient's debilitated condition. At first, until sufficient data was acquired, preliminary treatment was carried out in the hospital in all instances; but gradually it has become possible to make selections, so that now patients with mild hyperthyroidism are prepared outside the hospital. The medical measures employed for patients with severe forms of the disease consist of rest, adequate food

and fluid intake, digitalis as indicated, and the oral administration of iodine (Lugol's solution). By repeated basal metabolic estimations, at intervals of three to four days, the progress of the disease can be accurately watched. Improvement in the condition of the patients is usually apparent in from ten to fourteen days and a large number of these become safe risks for primary thyroidectomy. If doubt still exists as to operative risk, a preliminary surgical procedure, such as injection of hot water or a ligation, is indicated as a tolerance test. A further number of the patients who show no reaction to these procedures are judged good risks and the operation is then completed. Because of extreme loss of weight or strength, or because of the presence of marked visceral degenerative changes, in a small percentage (20 to 25 per cent) of the total number of patients with exophthalmic goiter, two ligations and a three months' period of rest are indicated.

The lowered operative mortality alone has fully justified the employment of the combined medical and surgical management of patients with exophthalmic goiter. Thus, during the last sixteen months ending May 1, there were 1398 operations on 853 patients with exophthalmic goiter: 13 died, a mortality by operation of 0.92 per cent, and by case of 1.5 per cent.

A comparison of the operative procedures employed in the first four months of 1923 with those of the same period for the five preceding years is interesting: Primary thyroidectomy was performed in 56 per cent of the patients in 1923, while the average for the five preceding years was only 38 per cent; 24 per cent of patients had two or more ligations before thyroidectomy in 1923, and the average for the five preceding years was 37 per cent. Expressed differently, under the combined medical and surgical management, primary thyroidectomy has increased 18 per cent and the necessity for two or more ligations has been reduced 12 per cent.

Adenomatous Goiter with Hyperthyroidism. The added dangers of surgery in this type of case are also due to the possibility of the development of acute hyperthyroidism and to the

presence of visceral degenerative changes. Owing to the usual mild intensity of hyperthyroidism the possibility of an exacerbation of severe acute hyperthyroidism is of relatively small significance, while the presence of visceral degenerative changes is the most influential factor in the mortality-rate. In this respect adenomatous goiter with hyperthyroidism differs from exophthalmic goiter. In cases of exophthalmic goiter the symptoms may begin gradually or abruptly, prior to, coincident with or shortly after the appearance of the goiter; thus the patient realizes early that he is not well and seeks relief soon after the onset. But in cases of adenomatous goiter with hyperthyroidism the patient has had a goiter without symptoms for many years, and the onset of hyperthyroidism is so insidious that the disease often progresses to a stage of visceral degeneration before he realizes any change in his condition, and operation is accordingly delayed. Because of this and because of the fact that preparatory measures are inadequate, the operative risk is relatively high.

During the past sixteen months there were 277 patients with adenomatous goiter with hyperthyroidism operated on: 9 patients died, a mortality of 3.24 per cent. It is obvious, therefore, that the mortality-rate is dependent more on the number of bad risk patients accepted for operation than on any factor in the operative or preoperative management. Because of the facts that the successful removal of the adenomatous tissue is followed in from ten to fourteen days by the complete subsidence of hyperthyroidism, and that the improvement is immediate in many of the otherwise hopeless cases, extension of the limits of operability to include nearly all patients is justified.

Conclusions. 1. In order to evaluate accurately statistics on the results of operations on patients with goiter, the knowledge of two facts is essential: The proportion of goiters without hyperthyroidism included in the computation, and the basis on which operative mortality is reckoned.

2. The operative risk in cases of goiter without hyperthyroi-

dism cannot be compared with that of goiter with hyperthyroidism: In the former the dangers are confined to the operative and postoperative accidents; in the latter the greatest danger lies in the disease itself.

3. The reduction of the mortality to 1 per cent in surgery of exophthalmic goiter is attributable to three factors: (*a*) Patients with exophthalmic goiter are coming to operation earlier in the course of the disease, before the development of visceral degenerative changes; (*b*) by the combined medical and surgical management the development of postoperative acute hyperthyroidism has been reduced to a minimum; and (*c*) a clearer recognition of the dangers involved in the injury of the recurrent laryngeal nerve has led the surgeon to greater care in its avoidance.

4. The combined medical and surgical management of patients with exophthalmic goiter is warranted from the economic standpoint, as it has reduced the necessity for ligations.

5. As preliminary measures are ineffectual in adenomatous goiter with hyperthyroidism, the mortality-rate is dependent on the number of bad risk patients accepted for operation.

REPORT OF CASES OF GOITER, JANUARY 1, 1922, TO MAY 1, 1923

	Cases.	Mortality.	Per cent.
Thyroidectomies for exophthalmic goiter*	703	6	0.85
Ligations preliminary to thyroidectomy for exophthalmic goiter	591	5	0.84
Hot water injections preliminary to thyroidectomy for exophthalmic goiter	101	1	0.99
Injections 0.5 novocaine preliminary to thyroidectomy for exophthalmic goiter	3	1	33.33

* The thyroidectomies were complete operations in one stage, except in two instances, in which the technical difficulties made it advisable to divide the operation into two stages.

DISCUSSION ON THE PAPERS OF DRS. TINKER, CHARLES H. MAYO AND J. DE J. PEMBERTON

Dr. George W. Crile, Cleveland:

This society has just heard two very interesting papers.

As to the use of iodin in the preparation of patients, Dr. Mayo made the statement some time ago that the cause of many thyroid conditions was deficiency of iodin, and Dr. Kocher called attention to the same point many years ago. I venture to say, however, that the improvement noted in the last six months is due more to the improvement in our surgical technic than to the use of iodin in the preparation of the patients. In a long series of cases I used iodin, and occasionally I do so now, but I have practically given it up. When it is used it is given for approximately twelve hours before the operation.

The next point that I would like to bring out is the preparation of the patients, in which respect I think our ideas have changed a great deal. Our time of preparation covers about three and a half days, during which time the patient is kept in the surgical service. Patients coming in with high temperature are refrigerated at once by literally packing them in ice. We push the circulation by giving 2 cc of digitalis every four hours for ten doses. Under all circumstances we push water both by mouth and by hypodermoclysis; although this sometimes makes the patient sick, it can be done in nearly every instance. I have given from 1000 to 2000 cc of water to these patients. To the patients whose vitality is feeble and pulse low we give blood transfusion, because by increasing the volume of blood we increase the circulation through the capillaries, thus assuring a sufficient blood supply to the myocardium, brain and other tissues. We use a local anesthetic and we perform all the "bad-risk" cases in the patients' rooms. Our series includes 4052 such operations. If we get the cases early enough we find that our mortality rate is almost exactly 1 per cent. I think Dr. Pemberton's statement is very true, that much of our improvement is due more to the proper selection of cases and early operation than to surgical management.

Dr. A. J. Ochsner, Chicago:

These papers are tremendously instructive and certainly deserve discussion.

I want to direct your attention to a method which has not been

very much practised here and which is an improvement on the ligation that is generally used.

Inferior thyroid arteries usually carry nearly double as much blood to the thyroid gland as the superior arteries do. A number of years ago Prof. de Quervain, of Berne, Switzerland, introduced a method of ligation of the inferior thyroid artery which is a great advantage over the method that we practise here. He makes an incision to the outer side of the sternomastoid muscle and separates the soft tissues down to the artery, carries his fingers up and down until he touches the inferior thyroid artery and then places an aneurysm hook around it and ligates it doubly and cuts between. The advantage of this method is that you keep entirely away from the recurrent laryngeal nerve and from the inferior parathyroids. The second advantage is the fact that you do not interfere with the nutrition of the parathyroids, which you sometimes do when you ligate the inferior thyroid artery near its entrance into the gland. In fact, in the very large series of cases that he has published there has never been any injury to these structures.

The third advantage, and an important one, is this: The outer portion of the collar incision of Kocher can be used for this purpose. If you wish you can ligate only one side with local anesthesia and then after several days ligate the other side, put in a stitch and then when you remove the thyroid you simply reopen the incision and make your transverse collar incision of Kocher and you have no deformity as a result.

I believe that this is a great advantage, and if you once try it I am sure you will always practise it. In the cases in which you ligate the superior thyroid there is always some deformity.

Dr. Miles F. Porter, Fort Wayne:

I have had in mind recently, borne out not by a large experience but, on the other hand, not small, that it should be possible for us to do away with the two-stage operation and to do away with ligation if we make proper use of boiling-water injections. My own experience is that I can do more with boiling-water injections than I can with ligations and two to four weeks in bed.

You can make your incision, following the idea just brought out by Dr. Ochsner, in the lines of the collar incision under local anesthesia, which can be done anywhere, and then you can inject not a few drops of water with the idea of testing the ability of the individual to stand the operation, but with the view of doing what you are aiming to do, by cutting off the blood supply. You can inject

both sides of the goiter. I never inject less than 20 to 30 or 40 cc. There is only one drawback, and that is that about 20 per cent of your patients will never come back for the end operation.

I have seen boiling water used a number of times in an inefficient manner and I would like to mention a couple of suggestions as to the method of using it. I have seen it taken from an adjoining room. That is not the way to use it. You want to have the syringe covered with rubber in boiling water at your hand. I make my incision and hold it open until I expose the capsule, then I introduce the syringe first on one side and then on the other and give each side 10 or 20 cc of water. By this method I think you can do away with ligation, and I want to emphasize Dr. Ochsner's objections to ligation. It does not do much good and it makes the subsequent removal of a goiter very much more difficult and leaves your patient with three ugly scars where he might have one that is fairly decent.

Dr. Tinker (in closing):

As regards the patients who should be classified as extremly toxic: Every year we get from 6 to 12 patients who die in from twenty-four to seventy-two hours after they enter the hospital in spite of everything that we can do to improve their condition to make them fit subjects for operation. It is true that a certain number of the profession are waking up to the gravity of the importance of these toxic goiters, but it is also true that in our section of the country we are still getting a large number of the extremely toxic type of patients who die from the disease and who do not need the help of any surgery.

Dr. Mayo (in closing):

As a result of thirty-five years' work on this subject of goiter, I improved the surgical procedures for such cases, and with this improved technic the mortality has been materially reduced, so that now very few deaths occur.

Another factor in reducing the mortality is the fact that these patients consult a surgeon earlier, as was shown by Dr. Pemberton's paper. Also we have had the opportunity to observe a large series of patients, because we have had nearly five times the number that Kocher had in his clinic up to the time of his death.

We have had a very low mortality, and this is greatly due to personal observations, training and experience; one can say from experience that one patient should do well or that another will probably die.

As to the question of treatment with iodin: Even in the worst

cases of exophthalmic goiter a material improvement has been observed following the administration of iodin for several days. In Europe they are using this in a hesitating manner. Kocher did as much harm to the operation of exophthalmic goiter as anybody else in his day, and he did not accept the surgical treatment until a few years before his death. The hyperthyroid case is having too much secretion lacking in iodin, but a normal secretion is made by adding iodin; the patient's condition improves and he is able to withstand operation.

The mortality in exophthalmic goiter operations, through care in technic, better preparation of patients and better after-care, has been reduced to 1 or 2 per cent, and every case marked "exophthalmic goiter" is one without question, and not one of dementia precox or nervousness, or a psychic condition associated with goiter.

A STUDY OF THE PATHOLOGICAL CHANGES OCCURRING IN THE SPINAL CORD FOLLOWING FRACTURE-DISLOCATION OF THE VERTEBRÆ

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In the following communication I shall try to describe simply and accurately the pathological changes, immediate and remote, that occur in the spinal cord when it is crushed by the displaced vertebræ in the condition known as fracture-dislocation.

Any consideration of direct wounds of the cord caused by penetrating bullets or shell fragments will be purposely omitted because these injuries stand in a class by themselves, in that they are compound fractures, and as such are liable to septic infection. Although infection is a rare complication in through-and-through bullet wounds, it often occurs in the ragged wounds produced by sharp pieces of shell, especially if the missile is retained in the spinal canal or carries in with it a piece of clothing. Apart from any consideration of the nervous injury, such wounds must be operated on to prevent death from septic infection, the object of the operation being solely the removal of the foreign body and the cleansing of the wound.

In crushes of the cord resulting from fracture-dislocation the nature of the injury is entirely different. There is no external wound and no danger of septic infection. Although the cord is often severely damaged by being pinched by the displaced vertebræ, the pressure is usually relieved by the recoil of the bones when the displacing force ceases to act. When the recoil

is complete the damaged cord lies in the canal, which is not narrowed or distorted, but is as roomy as it was before the injury. On this account operation is seldom advisable or justifiable.

Fracture-dislocations of the spine may occur from direct or indirect violence. Those caused by *direct violence* may follow an injury acting in a horizontal plane such as a direct blow or kick or a sidewise impact caused by a fall. If the point of impact is concentrated on a spinous process it may fracture it or drive it inward, together with the laminæ, against the cord, producing immediate symptoms of cord injury. If the spinous process and laminæ are strong and rigid the vertebra may be driven directly forward and dislocated. As a rule, the displaced vertebra retains its connection with the vertebræ above and the displacement forward affects the whole of the upper part of the spine. The intervertebral disc between it and the body of the vertebra below is torn or a portion of the bodies of both vertebræ are broken off obliquely. This may occur without fracture of the neural arch, or, in the cervical region, without even fracture of the articular processes, although the latter rarely escape injury. The cord is frequently crushed severely between the lamina of the displaced vertebra and the body of the vertebra below.

Fracture-dislocations by *indirect violence* are caused by the application of a force at a distance from the lesion. Thus a fall on the head will usually fracture the cervical spine, and a fall of a heavy weight on the nape of the neck will frequently fracture the thoracic vertebræ. Force acting downward along the thoracic spine, or upward along the lumbar spine, will frequently fracture the vertebræ at the thoracolumbar junction. The line of separation is usually through the intervertebral disc, but in addition the anterior surface of the bodies of the vertebræ may be chipped off obliquely and the articular and spinous processes broken irregularly. The vertebra above the lesion carrying the whole spine with it is displaced forward and downward on the vertebra below. If the displacement is great

enough the spinal cord is crushed between the lamina of the vertebra above and the posterior upper edge of the vertebra below. As a rule, the displacement persists as long as the force continues to act. As soon as the spine is straightened the deformity disappears because the vertebræ recoil to the normal position. In some cases, usually in the cervical region, and particularly where the articular processes of the vertebræ are not fractured, *i. e.*, in cases which are, strictly speaking, examples of a dislocation, the recoil does not occur and the resulting deformity persists. In most of these cases reposition is possible by manipulation under an anesthetic; but some cases resist all attempts at replacement.

It is of fundamental importance to emphasize the fact that vertebral recoil is the rule and that the moment the vertebræ return to their normal position the vertebral canal is restored to its former size. The cord is no longer subjected to pressure, and from this time on, if nervous symptoms persist, other factors must be held responsible.

The exact nature of these factors will be revealed by a careful study of the pathological changes in the traumatized tissues.

The Vertebræ. Sometimes the vertebral bodies escape injury completely, the line of separation passing accurately through the intervertebral discs. This is more frequently seen in the cervical region (Figs. 1, 2 and 3). In the thoracic and lumbar regions, although the main line of separation is along the intervertebral discs, the anterior surface of the body of the vertebra below the line of separation is usually chipped off obliquely. Occasionally the chipping affects the bodies of several vertebræ, including the body of the vertebra above the line of separation. Sometimes a considerable wedge of bone is chipped off; at others, the fragments of bone are of small size. It is caused partly by the direct impact of the displaced vertebra above and partly by the pull of the anterior common ligament which is torn up bodily from the front of the bodies of several vertebræ below the line of separation. In cases that die shortly after injury, extensive extravasation of blood can be seen, at

autopsy, in this situation. In rare instances the bodies of the vertebræ are fissured transversely (Fig. 8). The articular processes rarely escape injury. In the cervical region, if anterior flexion of the upper vertebræ is extreme at the time of the accident, the ligamenta subflava and interspinous ligaments may be torn and the articular processes of the displaced vertebra may be carried forward in front of the lower without breaking either one (dislocation). Usually, however, one or both articular processes are fractured. In the thoracic and lumbar regions fracture of the articular processes is the rule. In rare instances, however, when flexion of the spine is excessive, they may ride over one another without breaking. In addition the displacement frequently tears up one or more spinous processes. The laminæ and pedicles are rarely broken in fracture-dislocations caused by indirect violence. Where the violence is direct both laminæ and pedicles are frequently fractured.

The Spinal Canal. In cases where the recoil is complete the spinal canal is not narrowed or encroached upon in any way. Narrowing of the canal is seen only in cases of pure dislocation or fracture-dislocation where reduction is incomplete, and in cases of fracture of the laminæ from direct violence where the bone has been driven inward.

Extravasation of Blood in the Spinal Canal. Even in cases operated on, or autopsied early or within the first week, the quantity of blood found between the bone and dura mater is very small. We have never seen an extravasation large enough to cause pressure on the cord or even to cause the dura mater to bulge toward the cord. These observations are in complete accord with those of Thorburn and others. Occasionally we have found small worm-like extravasations situated several vertebræ below the crush.

The Dura Mater. Tears of the dura mater are rarely seen except in direct wounds. Those seen in museum specimens are usually made during the removal of the cord. During operations on recent cases in which complete recoil of the vertebræ has occurred there is ample space between the bone and dura. In

old, standing cases the dura is often very adherent to the ligamenta subflava and the laminæ of the vertebra, especially when marked deformity exists. Adhesions are also frequently seen between the dura and pia in old cases where deformity persists and the cord is crushed completely (Fig. 22).

The Arachnoid. As in the normal state, the arachnoid is closely applied to the inner surface of the dura mater. In recent cases the subarachnoid space is not narrowed. There is free circulation of subarachnoid fluid across the site of the crush. The fluid is often blood-stained, but it is rare to find it so thickly mixed with blood as we see it in some fractures of the base of the skull. Clots are rarely seen. When present they are very small and are found clinging to the surface of the crushed pia mater. We have never seen a clot large enough to produce pressure on the cord or even to fill the subarachnoid space. In old, standing cases the arachnoid may adhere to the surface of the pia and interrupt completely the subarachnoid space above and below the adhesions (Case 13 and Fig. 22).

Pia Mater. Except in direct wounds the pia mater is seldom torn. Although it is a thin membrane, it is very tenacious. Even in examples of complete pulping and crushing of the cord the disintegrated nervous matter will be forced upward and downward along the intact pia mater, which rests in the dural sheath like a tube or sleeve of fine gauze stretching between the proximal and distal ends of the cord. In cases where the vertebral deformity persists the disintegrated nervous matter is prevented from returning into the tube of pia. Consequently at operation or autopsy a thin, flattened tape-like tube of pia is seen holding together the severed ends of the cord. This condition is shown in Figs. 18 and 23. Extravasations of blood between the pia mater and the cord are usually minute in size. Most of them are the superficial outcrops of the larger foci extravasated in the depths of the cord.

Spinal Cord. It is vitally important to visualize the structural changes that occur in the architecture of the cord and to estimate them at their true value. The primary effect of

injury, whether it be a direct crush or a molecular vibration produced by a penetrating missile or by a contusion, is to destroy the ganglion cells, axis-cylinders and myelin sheaths by shaking them loose from their supporting network of glial tissue, reducing them frequently to a hopeless pulp of disintegrated material in which it is impossible to recognize the essential nervous elements, or in fact to distinguish any structure except the lace-work of the neuroglia. There is, of course, extravasation of blood, because such destructive processes cannot occur without tearing bloodvessels. The extravasations, however, are small and are confined, as a rule, to the injured zone. There is no tendency for the blood to travel into areas which have escaped injury. In recent cases the extent of the area of nervous destruction is often graphically indicated by discoloration from extravasated blood which occupies the interstices of the glial network from which the nervous elements have been squeezed by the crush. This is shown not only in human cords removed at autopsy but in the cords of dogs traumatized experimentally. The area and shape of the disintegrated area are very uniform when the nature of the force producing it is also uniform and focused. Conversely it may be just as irregular when the force is applied irregularly and is diffused. Thus in crushes of the cord produced by displaced vertebræ or those produced experimentally by carefully applied and graduated force the injured areas are surprisingly alike; whereas in those produced by missiles or contusions they are subject to many variations in size and shape. The crushed area is often indicated by the presence of extravasated blood which can be seen through the pia mater if it is near the surface of the cord. In many cases where the whole thickness of the cord has been crushed for an appreciable distance a dark band or ring of extravasated blood may indicate the injured area. This is frequently seen in the cords of dogs crushed by the pulp of the experimenter's finger. Such cords often show an area of discoloration extending upward and downward from the bruised level, which represents the area of destruction. These areas are cone-shaped united at

their bases, which correspond to the line of crush, and tapering upward and downward in the substance of the cord. Thorborn and Richardson, who first described this peculiarity, found that the lower cone was more truncated than the upper. This appearance is so constant that it suggests strongly that the mechanism of destruction is a vibratory wave which starts at the point of impact and exerts a divulsive action on the friable nervous tissue. It can be imitated very closely by crushing transversely a ripe banana in its skin with the edge of a ruler or a lead-pencil. A horizontal section will show cones of bruised pulp exactly like those seen in the spinal cord, which stand out in striking contrast with the sound pulp if the fruit is kept for twelve hours.

As a rule, the disintegrated area can be distinguished by its blood-stained appearance. It is probable that some degree of extravasation always accompanies disintegration. It must, however, be emphasized that massive hemorrhages and clots never occur even at the site of greatest destruction. It has appeared to us that the disintegration is more marked at the point of impact and that the cone-shaped areas of destruction occupy the center of the cord without any particular preference for either gray or white matter. This feature will be considered later in the description of actual specimens. Apart from discoloration at the point of impact the appearance and shape of the cord may show no change. Even where its substance is completely crushed the disintegrated material may flow back into the uninjured sleeve of the pia mater and fill it up completely, so that it looks as symmetrical as it did before the injury. If, however, pressure is kept up for a long period the cord will remain narrowed permanently. We shall picture such cords later.

The foregoing remarks are founded mainly on a study of the spinal cords preserved in the pathological museum of the University of Texas. We shall now proceed to describe their pathological features. For convenience we have divided them arbitrarily into four groups: In the first group we have placed

the cases of instantaneous death caused by a crush above the origin of the phrenic nerve. The second group contains the case living a few days only, the third a few weeks, and the fourth a longer period.

FIG. 1.—Case I. Photograph after recoil.

GROUP I.—CASES OF INSTANTANEOUS DEATH

CASE I.—McG. John Sealy Hospital. Autopsy No. 524. The patient, aged forty-two years, fell down an elevator shaft and was picked up dead. Abnormal mobility with crepitus was found in the lower cervical region.

The autopsy revealed a fracture-dislocation at the level of the intervertebral disc between the fifth and sixth cervical vertebræ. The fifth vertebra carrying the upper vertebræ with it

had been displaced forward on the sixth. The recoil as shown in Fig. 1, was practically complete and very little deformity was present. The interspinous ligament between the fifth and sixth spines was completely torn. Evidently the spinal column had

FIG. 2.—Case I. Deformity reproduced.

been bent acutely forward and the fifth vertebra displaced forward to a considerable distance, crushing the cord severely. Extensive pulping of the cord tissue can be seen. It is shown by longitudinal streaks of disintegrated tissue which extend upward

as high as the middle of the third cervical vertebra and as low as the upper border of the seventh. The lower area shows cavitation. There is no sign of hemorrhage either in the membranes or in the substance of the cord. Death was practically instantaneous because the crush was above the origin of the upper roots of the phrenic nerves.

A longitudinal section of the fractured spine is shown in Fig. 1. In Fig. 2 the deformity has been reproduced to show the mechanism of the fracture and the kind and degree of deformity.

No microscopical sections were made of the specimen, because it had been frozen and divided with a saw before being mounted, and we were afraid that the nervous structures would be seriously injured and distorted by the mechanical injury.

Case II.—J. B. John Sealy Hospital. Autopsy No. 501.

The patient fell down an elevator shaft and was picked up dead. There was abnormal mobility of the upper part of the neck with crepitus.

The autopsy revealed a fracture-dislocation of the cervical spine which showed some unusual features. The line of separation between the bodies of the vertebræ passed between the second and third cervical. The intervertebral disc was ripped up completely from its bed. It is held in contact with the displaced body of the second by the anterior common ligament. Both pedicles of the arch of the axis (second) were broken. The interspinous ligament between the atlas and axis was torn through completely and the separation between the posterior arches of these vertebræ was so great that the dura mater could be felt by the finger. The line of separation between the vertebræ was therefore very irregular and oblique, to-wit, between the bodies of the second and third, through the pedicles of the second and between the arches of the first and second.

There was no hemorrhage to speak of in the soft tissues of the neck and none at all in the extradural space. The intradural space was free from hemorrhage. The cord showed no signs of bruising. It did not appear to be compressed, nor were

there any hemorrhages in its substance. A slight angular bend is shown in Fig. 3. The absence of hemorrhage is probably due to the instantaneous death. In this respect it is analogous to Case I.

On account of the method of preparing the specimen, namely, freezing and sawing, no microscopical sections were made.

Remarks. In both cases there are two conditions worth emphasizing: (1) The absence of hemorrhage either in the cord

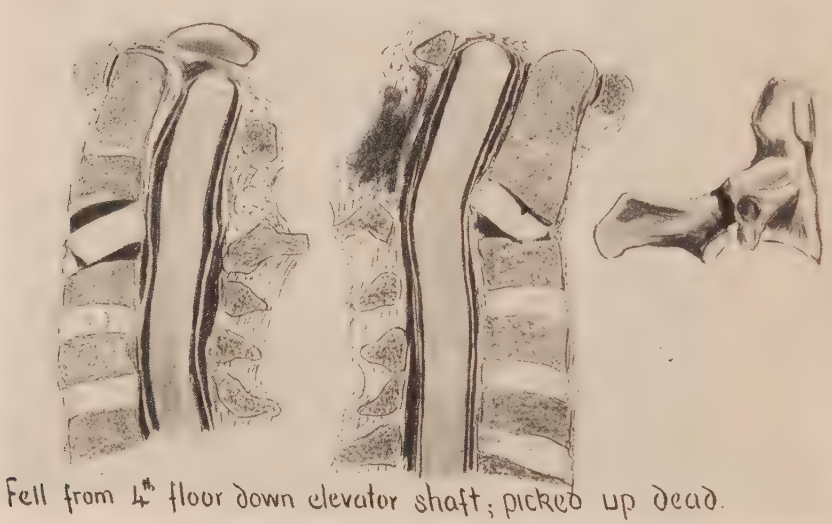

FIG. 3.—Case II. Drawing in the center shows the deformity; that on the left, the appearance after recoil.

or in the structures around it, and (2) the complete recoil of the vertebræ with restoration of the spinal canal and release of the pressure on the cord. Instantaneous death accompanied by immediate arrest of the heart's action would explain the former.

GROUP II.—CASES DYING A FEW DAYS AFTER THE INJURY

CASE III.—L. P. C. John Sealy Hospital. No. 131,212. Autopsy No. 1627.

The patient was admitted to John Sealy Hospital on October 16, 1922, showing symptoms of a total transverse lesion of the spinal cord associated with a fracture-dislocation of the spine.

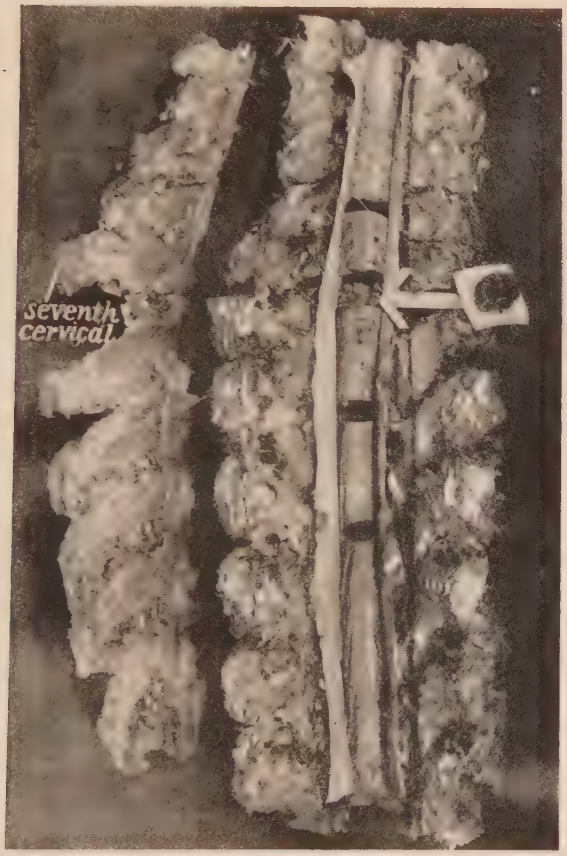

FIG. 4.—Case III. Slight angular deformity; absence of hemorrhage in meninges; hemorrhage without marked crushing of the cord.

which had resulted from a direct crush between an elevator and the floor. He was suffering from severe shock and consequently the examination of the motor and sensory functions was very unsatisfactory. The ulnar border of the forearm and

ulnar half of the hand were insensitive and flexion of the wrist impossible. There appeared to be complete anesthesia and flaccid paralysis below the level of the seventh cervical segment. The patient remained in a condition of profound shock until his death, which occurred twenty-four hours after the injury.

At the autopsy a fracture-dislocation was found (Fig. 4), the line of separation passing between the bodies of the seventh cervical and first thoracic vertebræ. There was very little original deformity and the spinal canal was not much narrowed. A large extravasation of blood was found in front of the bodies of the vertebræ under the anterior common ligament. It extended downward as far as the mid-dorsal region. There was no blood in either the extradural or the intradural spaces in the neighborhood of the lesion. A very small worm-like clot was found clinging to the outer surface of the pia mater, about 3 inches below the lesion. The cord at the level of the lesion was slightly flattened but not disintegrated. Several small hemorrhages were seen on its outer surface. Both dura and pia mater were intact.

A section of the cord taken through the lesion is shown in Fig. 5. The cord is flattened in front, and both white and gray matter are distorted. Numerous hemorrhagic foci are seen scattered throughout the section in both white and gray matter. The gray commissure is completely hemorrhagic. A noticable feature is the complete absence of the changes usually associated with edema. The cord is not swollen. On the contrary it is smaller than normal and the pia mater is wrinkled. In spite of the flattened, distorted shape of the cord the sheath of the pia mater is intact everywhere. The wrinkling shows best on its posterior surface. Identical findings are shown in the dog's cord pictured in Fig. 28.

The microscopical findings do not reveal enough destruction to justify a conclusion that the conductivity of the cord was destroyed completely and permanently. It is probably that if the patient had lived long enough both motion and sensation would have been restored to a considerable degree.

At the autopsy a gangrenous appendix was found. It had not perforated. The patient was feeling very sick when he started work on the morning of the accident, and the mishap was caused probably by his lack of alertness.

FIG. 5.—Case III. Photomicrograph of site of lesion, showing hemorrhage and slight flattening.

CASE IV.—R. B. History No. 8799. Autopsy No. 1650.

The patient was admitted to John Sealy Hospital on January 29, 1923, deeply intoxicated with alcohol. There was a history of a fall of about fifteen feet. We were unable to get accurate information as to when the accident occurred. It is probable,

however, that he was hurt on the night of January 28, the day before his admission. He died at noon on January 30. He probably lived about forty hours after the injury. The intern who examined his chest on the afternoon of his admission said

FIG. 6.—Case IV. Extensive destruction, with pulped cord flowing through tear in pia.

that he was able to hold his body in a sitting posture during the examination. This statement is probably not reliable, because the patient was comatose from alcohol and was supported by an orderly.

Fractured spine was suspected during the visit of the attending physician on the morning of January 30. The patient was semi-conscious and the examination was unsatisfactory. There was flaccid paralysis of both lower extremities and complete anesthesia. All the deep reflexes were absent. He was unable to move his arms. Sensation in the arms and forearms was indeterminate. He was not conscious enough to justify any conclusions. Examination of the muscle reflexes was very

FIG. 7.—Case IV. Photomicrograph of cord 1 cm. below crush.

definite. There was well-marked response in the biceps, triceps and extensors of the forearms. From this we thought the spinal lesion had not destroyed the seventh cervical segment completely. The superficial reflexes of the abdominal wall were also present. Spinal puncture showed uniformly bloody fluid.

The autopsy showed a fracture-dislocation between the fifth and sixth cervical vertebræ with slight displacement of the

fifth on the sixth. Unfortunately the crushed segment of the cord was seriously damaged during its extraction, because as soon as the dura mater was opened the softened cord oozed out. A photograph of the gross specimen is shown in Fig. 6. The level of the lesion was crushed to a shapeless pulp permeated throughout with extravasated blood. No microscopical section was made here because it seemed to be completely disorganized. The gross appearances of the cord about 1 cm. above and below the lesion are shown in the picture. In that taken from above there is widespread extravasation of blood in the gray matter of both anterior cornua and in the deep part of the posterior columns abutting on the posterior commissure. In that taken from below the cord is flattened obliquely and the extravasation is confined mainly to the center of the section. From the upper end of this section, through the part nearest the pulped area, the specimen shown in Fig. 7 was prepared. It shows such distortion of the cord that orientation was rather difficult. The anterior and posterior horns of one side and practically all the posterior columns of both sides are pulped. The crushed area is permeated with extravasated blood and completely shattered.

Case V.—H. W. John Sealy Hospital. Autopsy No. 1289. The patient was admitted to John Sealy Hospital on January 21, 1919, suffering from symptoms of a complete transverse lesion of the spinal cord at the level of the seventh cervical segment of the cord, caused by a fall on the back of his head. When first admitted he could distinguish pin-pick over several irregular areas in both legs. Later on there was complete flaccid paralysis, with absent reflexes and complete anesthesia to all types of stimuli below the lesion. He could move the arms and forearms sluggishly. He could flex the fingers of both hands slightly but could not extend them. There was complete loss of control of the bladder and the rectum.

The *x*-ray showed that the body of the sixth cervical vertebra was broken and that it was separated slightly from both the fifth and seventh.

The patient failed rapidly. Breathing became labored, and before death Cheyne-Stokes respiration set in. He died January 27, *i. e., six days after the accident.*

The autopsy showed softening and separation of the intervertebral discs between the fifth and sixth and between the sixth and seventh cervical vertebræ. The body of the sixth was fractured transversely (Fig. 8) and the right transverse process was broken off. There was a very small hemorrhage between

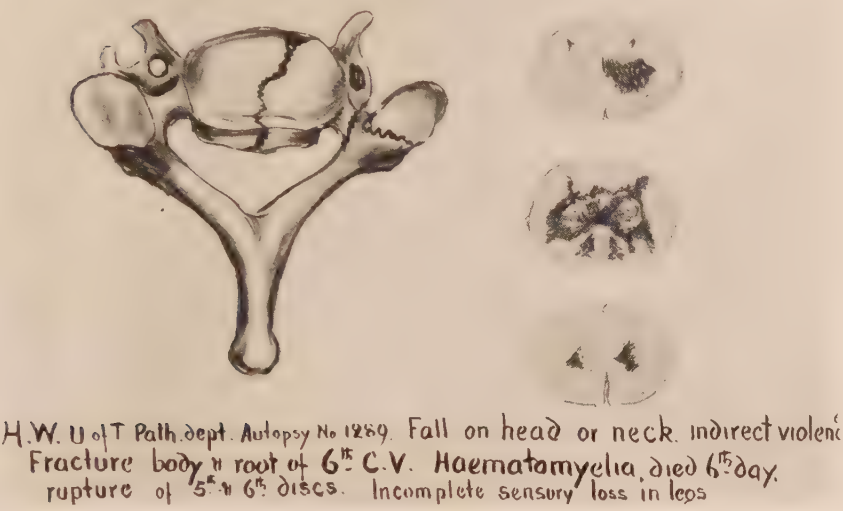
H.W. U of T Path. dept. Autopsy No 1289. Fall on head or neck. indirect violenc
Fracture body & root of 6th C.V. Haematomyelia. died 6th day.
rupture of 5th & 6th discs. Incomplete sensory loss in legs

FIG. 8.—Case V. At the right are shown the hemorrhages above, through and below the lesion.

the dura mater and bone at the level of the body of the sixth thoracic, but none inside the dura mater. The spinal cord at the same level was soft, flattened and dark colored from hemorrhagic extravasation in its substance. Unfortunately the whole cord was not preserved. Three blocks of the cord, taken respectively through the lesion, above it and below it, were kept permanently. (No. 2139, I.) The appearance of these sections is shown somewhat diagrammatically in Fig. 8.

At the level of the lesion the cord was seriously crushed and there was considerable extravasation of blood throughout the gray matter. There were also two wedge-shaped symmetrical extravasations on either side of the anterior median fissure. The section taken 2 cm. below the lesion showed two small symmetrical extravasations in each anterior cornu. In the section taken about a vertebral segment above the lesion the hemorrhage was confined mainly to one anterior horn. The

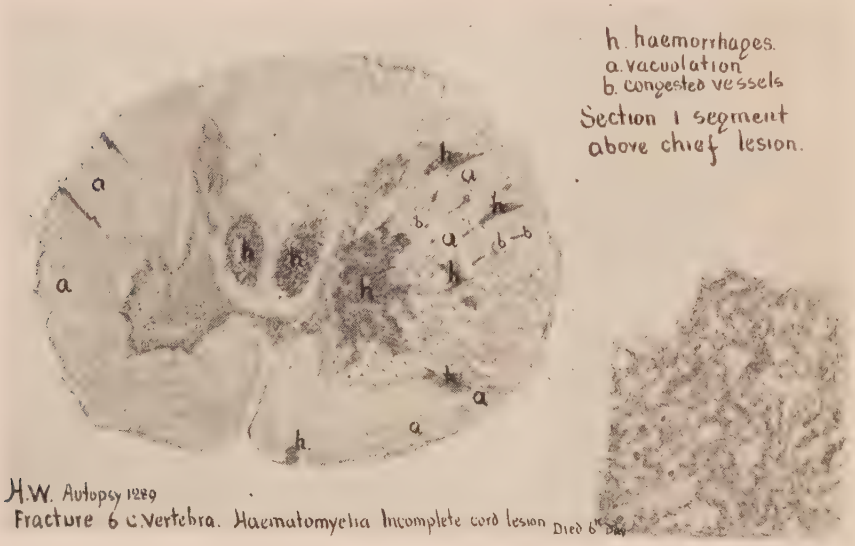
h. haemorrhages.
a. vacuolation
b. congested vessels
Section 1 segment above chief lesion.
H.W. Autopsy 1289
Fracture 6 c. Vertebra. Haematomyelia Incomplete cord lesion

FIG. 9.—Case V. Drawing of microscopic section above lesion.

microscopical appearances are shown in Fig. 9. The areas of hemorrhage are shown at *h. h.* Vacuolation is present at the periphery *a. a.* Edema is present everywhere. It is especially intense in the neighborhood of the hemorrhagic zones. The changes here seem to suggest that the open network appearance of the tissues surrounded by blood extravasation may represent the early stage of liquefaction of the disintegrated tissues, which may finally terminate in the formation of vacuoles or actual cavities like those occurring in syringomyelia.

Remarks. The 3 cases lived respectively twenty-four hours, forty hours and six days. In all of them we found extravasation of blood scattered alike in gray and white matter. It was the outstanding feature. The degree of destruction at the level of the lesion varied greatly. In Case III the anterior part of the cord was compressed and distorted. In Case IV, one-half the cord was pulped and destroyed. In Case V, the cord was crushed and flattened, but not completely destroyed. There was no edema in either Case III or in Case IV, but in Case V edematous changes were seen in every section. In the cord above the lesion they were especially intense. It would appear from the absence of edema in Cases III and IV, who survived respectively twenty-four and forty hours, that it does not make its appearance so soon after the injury as some observers claim. There is no difficulty in recognizing it when present. The tissue assumes an open network appearance that is absolutely characteristic. It has appeared to us that some of the edematous areas situated in the middle of dense extravasations of blood were in the early stages of liquefaction. In most of the sections we found edema more marked at the periphery, and especially in the lateral and posterior columns. In these situations it appears to represent the early stages of tract degeneration.

GROUP III.—PATIENTS LIVING FROM TWO WEEKS TO A MONTH

CASE VI.—A. S. Hospital No. 103,459. Autopsy No. 915. Admitted to John Sealy Hospital on September 24, 1915, suffering from complete paralysis and anesthesia of the body below the level of the second thoracic segment caused by a bullet which had passed across the upper part of both left and right pleural cavities. The signs were those of a complete transverse lesion, namely, absolute flaccid paralysis, total absence of every kind of sensation below the lesion and loss of control of bladder and rectum. Both deep and superficial reflexes were absent and never returned. The patient died October 7, *i. e.*, thirteen days after the injury.

The autopsy showed a wound of the right lung, fracture of the third left rib and a perforation of the body of the third thoracic vertebra. In addition there was purulent cystitis and acute diffuse nephritis. The spinal cord was removed and the spinal canal carefully examined. There was no direct wound of the cord. The track of the bullet was shown by a slight elevation of the bony wall of the spinal canal in front. The dura mater was slightly torn. The cord and pia mater were

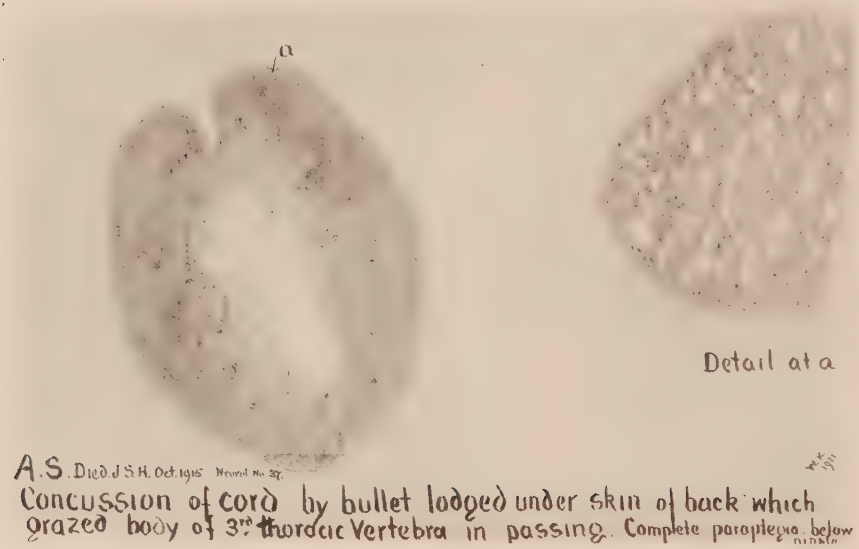
a
Detail at a
A.S. Died J.S.H. Oct. 1915 Neurol No. 37
Concussion of cord by bullet lodged under skin of back which grazed body of 3rd thoracic Vertebra in passing. Complete paraplegia below

FIG. 10.—Case VI. Drawing of microscopic section through lesion.

untouched. There was a small extravasation of blood in the extradural space but none in the subdural. The cord was slightly blood-stained and softened. It did not appear to be completely crushed.

A section of the cord through the lesion is shown in Fig. 10. The area of greatest destruction is in the gray matter and the posterior columns. Extensive cavitation is present in this area. Edematous changes are present in every part of the undestroyed cord. The detailed appearance of the edema and vacuolation

are shown in the insert at *a*. A section of the cord taken 2 cm. above the lesion (Fig. 11) shows two principal areas of destruction, one in the gray matter of one posterior horn and the other in the lateral column of the same side. The position of the posterior

FIG. 11.—Case VI. Photomicrograph 2 cm. above the lesion, showing edema and cavitation.

horn is occupied by a pyriform-shaped cavity. On the lateral wall of this cavity some of the nerve fibrils of the posterior horn can be seen. The cavity in the lateral column occupies the position of the spinothalamic tract. Its walls are formed by disintegrated tissue and are poorly defined. In a similar position

in the opposite lateral column there is an area of degeneration. Edema is well marked throughout the section.

Remarks. The area of destruction was much greater than we expected to find from the naked-eye characters of the cord. Although the greater part of the lateral columns seem to have escaped disintegration they are seriously shattered. The gray matter was completely destroyed for the distance of one spinal segment at the least. It is interesting to note that cavitation was also present in the section taken 2 cm. above the lesion. It is more than probable that the lesion was anatomically a complete transverse one. The case is particularly interesting because there was no direct wound or crush of the cord. The lesion was caused by vibratory impulses transmitted by the bullet during its passage through the body of the vertebra. Such cases are examples of pure concussion.

Case VII.—W. L. U. S. P. H., No. 905. Autopsy No. 1415. Admitted into John Sealy Hospital, September 9, 1920, suffering from complete paralysis and anesthesia below the level of the tenth thoracic nerve, which had resulted from a fall of 30 feet into the hold of a ship. The back and legs were bruised. The symptoms were those of a complete transverse lesion, namely, complete flaccid paralysis, complete anesthesia to every form of stimulus, absence of complete reflexes and complete loss of control of the bladder and rectum. The *x*-ray report pointed to a dislocation of the tenth thoracic vertebra. September 11 (*i. e.*, two days after admission) laminectomy was performed by another surgeon. The laminæ of the tenth, eleventh and twelfth thoracic vertebræ inclusive were removed. Neither fracture nor dislocation was found. The fat and muscle over the vertebræ was infiltrated with blood. No blood was found in the spinal canal. No lesion of the cord was seen.

The patient died October 5, (*i. e.*, twenty-six days after injury) the cause of death being probably renal sepsis. During this period there was no amelioration of the symptoms. Reflexes never returned.

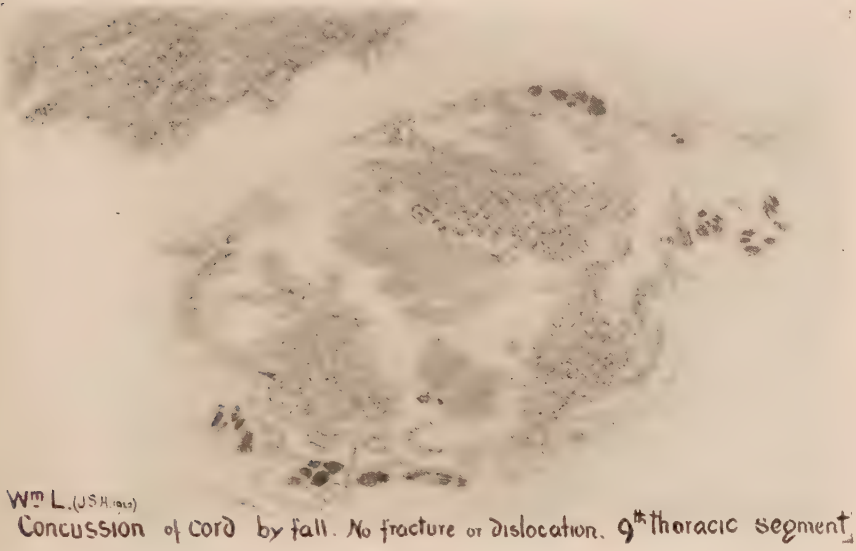

FIG. 12 *A*.—Case VII. Extensive pulping from concussion.

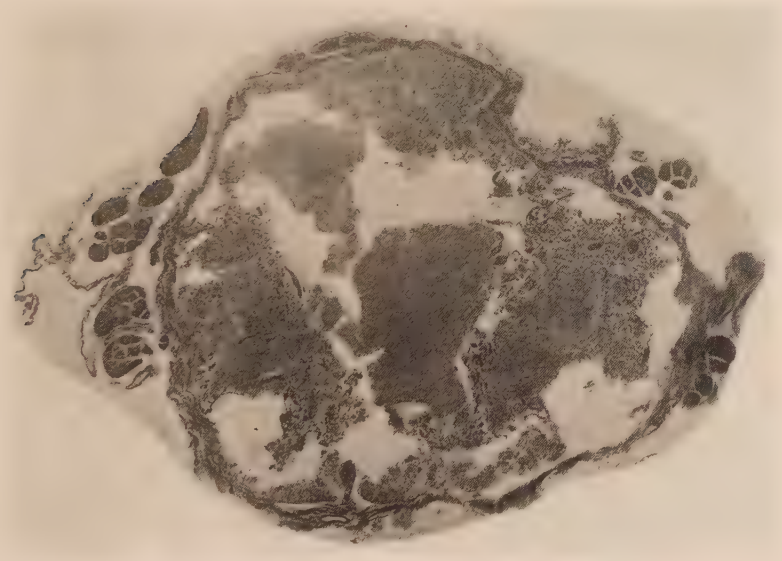

FIG. 12 *B*.—Case VII. Photomicrograph of Fig. 12 *A*.

The autopsy was limited to an examination of the brain and spinal cord, which was done very carefully by Drs. W. Keiller and H. O. Knight. There was no evidence whatsoever of any fracture or dislocation of the vertebræ or any distortion of the spinal canal. The operation had failed to expose the site of the lesion of the cord, which was at the level of the ninth thoracic segment. At this spot the cord was softened and diffluent. Above and below the lesion there were cavities filled with blood and disintegrated nervous matter. There was no hemorrhage either extra- or intradural. The microscopical appearance of the injured segment is shown in Fig. 12. The normal tracts and areas are almost unrecognizable. Nothing except a nebulous mass of disintegrated tissue can be seen.

Remarks. The case is a striking example of the effects of vibratory impulses on the cord. The absence of fracture or dislocation was proved beyond the shadow of a doubt by a painstaking examination conducted by two experts with the expressed purpose of finding out whether concussion was responsible for the symptoms or whether a fracture-dislocation had been overlooked at the operation. At the autopsy there was effusion of blood in the spinal muscles over the greater part of the dorsal region. The mechanism of the fracture was probably a direct blow, probably horizontal in direction, caused by the impact of the back against the combing of the lower deck. Such complete destruction is unusual. The vibratory impulses must have been excessive and concentrated. No hope of recovery was possible, because all conducting paths were totally destroyed.

Case VIII.—F. L. John Sealy Hospital, No. 120,527. Surg. Path., No. 1365. Medical, No. 459.

The patient, a male, aged thirty-two years, received a direct blow on the lower cervical spinous process from the handle of a hand car July 7, 1920. The symptoms of a complete transverse lesion at the level of the sixth cervical segment were noticed at once. He was brought from Mexico to Galveston

and arrived ten days after the injury. He was completely paralyzed and anesthetic below the level of the fifth segment. All reflexes were absent. There were bed-sores on the buttocks and heels. There was retention of urine and all the signs of septic cystitis. X-ray examination showed considerable forward displacement of the sixth cervical vertebra on the seventh.

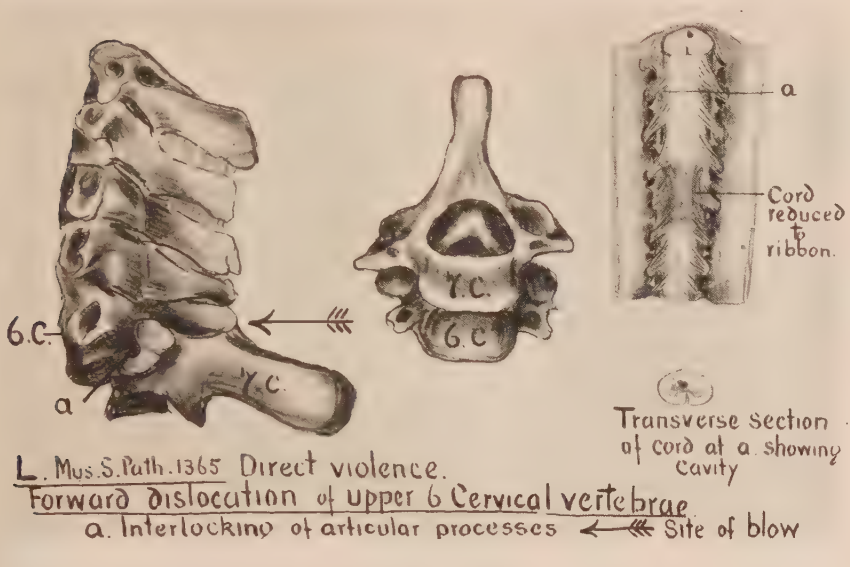

FIG. 13.—Case VIII. Drawing showing deformity; narrowing of canal and total crush of cord.

He was very septic on admission, but later on the fever disappeared. Two days before his death respiration became very slow, from 6 to 8 per minute. He died of respiratory failure twenty days after the injury.

The autopsy was made after careful embalming The sixth vertebra was found displaced forward on the seventh so far that the spinal canal was occluded and the cord completely crushed (Fig. 13). The right upper articular process of the seventh vertebra was fractured. There was no meningeal hemorrhage. At the level of the lesion the cord was completely

pulped and squeezed out of the sheath of the pia mater for at least ½ cm. The pulping of the cord extends upward and downward for at least a spinal segment in each direction, *i. e.*, it includes the seventh and eighth spinal segments. On section of the cord above and below the lesion a central degeneration and hematomyelia extended upward as far as the fourth segment and downward as far as the first thoracic segment. There was no adhesion of the dura mater and arachnoid to the pia

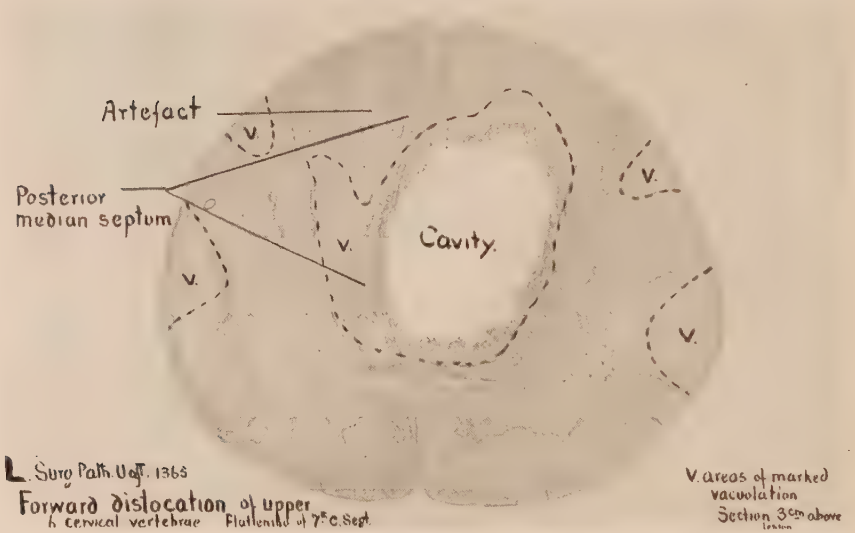

FIG. 14.—Case VIII. Drawing of microscopic section 3 cm. above the lesion.

and the subdural space above the lesion communicated freely with that below.

The appearance of the injured cord is shown in Figs. 13, 14, 15 and 16. At the site of the crush all trace of nervous tissue had been squeezed out of the pial sheath. A section at this level showed nothing but pia mater and nerve roots. A section taken 3 cm. above the crush (Fig. 14) showed a large cavity situated in the posterior column of white matter. It occupies the central part of the columns of Goll and Burdach on one side

and abuts on the posterior cornu and the gray commissure. In the section taken 2 cm. below the lesion (Fig. 15) a smaller cavity was seen occupying approximately the same position. Numerous small extravasations of blood are present in the gray matter and in the white matter of the lateral columns. At the periphery of the section, especially in the region of the lateral columns, there are marked evidences of edema. The section taken 2 cm. below the lesion shows similar changes.

FIG. 15.—Case VIII. Drawing of microscopic section 2 cm. below the lesion.

The cavity is much smaller and seems to be divided into two parts by a septum of disintegrated tissue. There is a localized edema at the periphery of the lateral columns. (See Case XII and Fig. 26.)

Remarks The great interest of this case lies in the cavitation of the interior of the cord. In discussing the mechanism of crushes of the cord mention was made of an area of disintegration which extended from the part crushed upward and downward.

This was shaped like two truncated cones, the bases of which face one another at the site of the lesions while the apices point upward and downward.

Soon after the injury the cone-shaped pulped area presents a characteristic appearance. It is intraversed in every direction by fissures which split it up into irregular masses and which

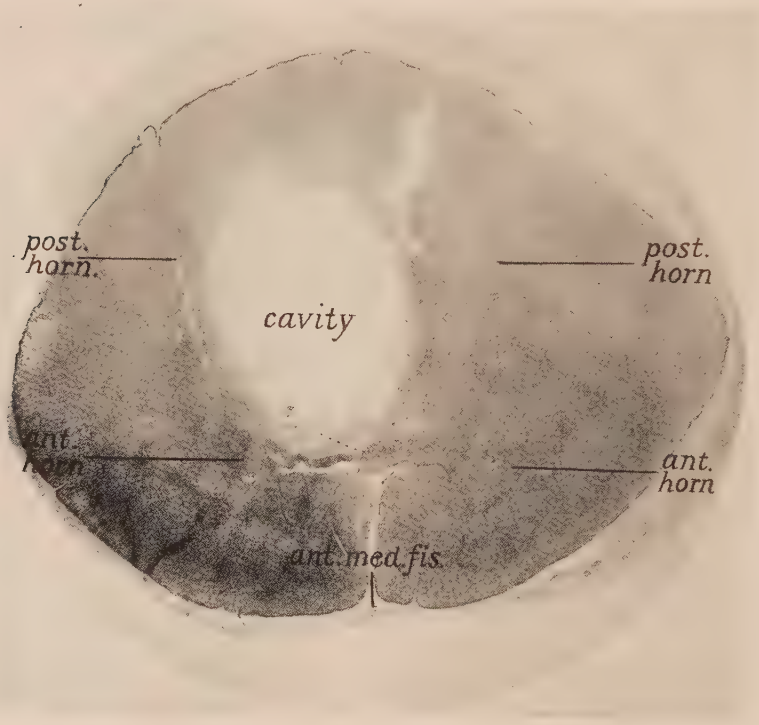

FIG. 16.—Case VIII. Photomicrograph 3 cm. above the lesion.

separate it from the uninjured cord which surrounds it. Diffuse extravasation of blood is present in every part of the pulped area. Later on the whole area has a tendency to undergo liquefaction, which may be followed either by absorption resulting in spaces resembling those found in syringomyelia or by the formation of cystic spaces containing a thin, fatty fluid resembling pus in appearance.

GROUP IV.—CASES LIVING SIX WEEKS AND OVER

CASE IX.—Museum, No. 22, J.

A museum specimen with practically no history (Fig. 17).

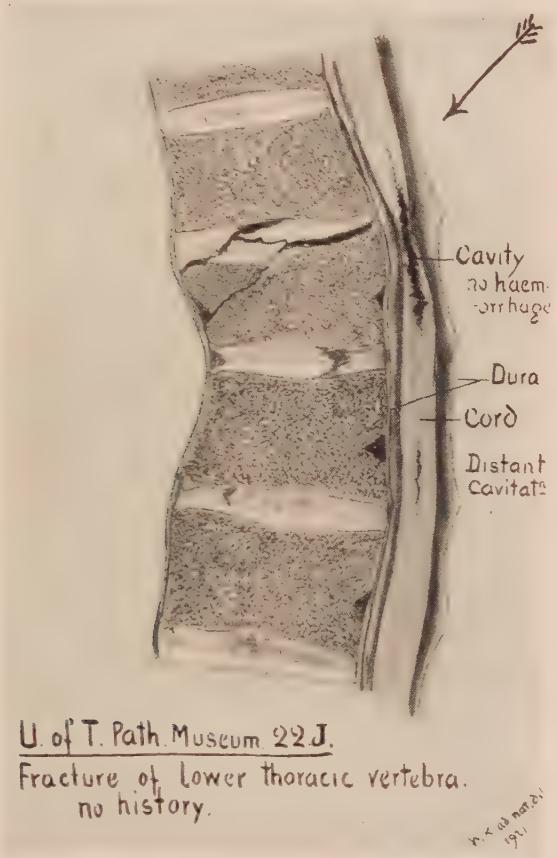

FIG. 17 *A*.—Case IX. Drawing showing vertebræ after recoil; cavitation in the cord.

The appearance of the bone and soft parts leads us to believe that the patient must have lived a considerable time after the accident. There is no sign of extravasation of blood anywhere.

The body of the eleventh thoracic vertebra is fractured obliquely. From this the line of separation passes backward between the tenth and eleventh vertebræ, ripping up the intervertebral disc and tearing through the interspinous ligament. The cord has

FIG. 17 *B*.—Case IX. Photograph of cord *in situ*.

been crushed very severely along the line of separation. It is respresented by a cavity with walls of pulpy tissue. Above and below the crushed segment conical areas of disintegrated tissue are seen. They occupy the center of the cord and are

shown in the photograph by a dark stippling. Their bases abut on the injured segment and their apices extend upward and downward to the middle of the corresponding vertebra. Oppo-

FIG. 18.—Case X. Cord flattened at site of lesion; increased in size above and to a less extent below.

site the middle of the body of the twelfth thoracic the center of the cord is occupied by a small cavity. A similar one, much smaller, is seen above opposite the upper part of the body of the eleventh. No microscopical sections were made of this spe-

cimen because we were afraid that the method of preparation had changed its minute characters. It was prepared by freezing and sawing the spine and cord sagittally.

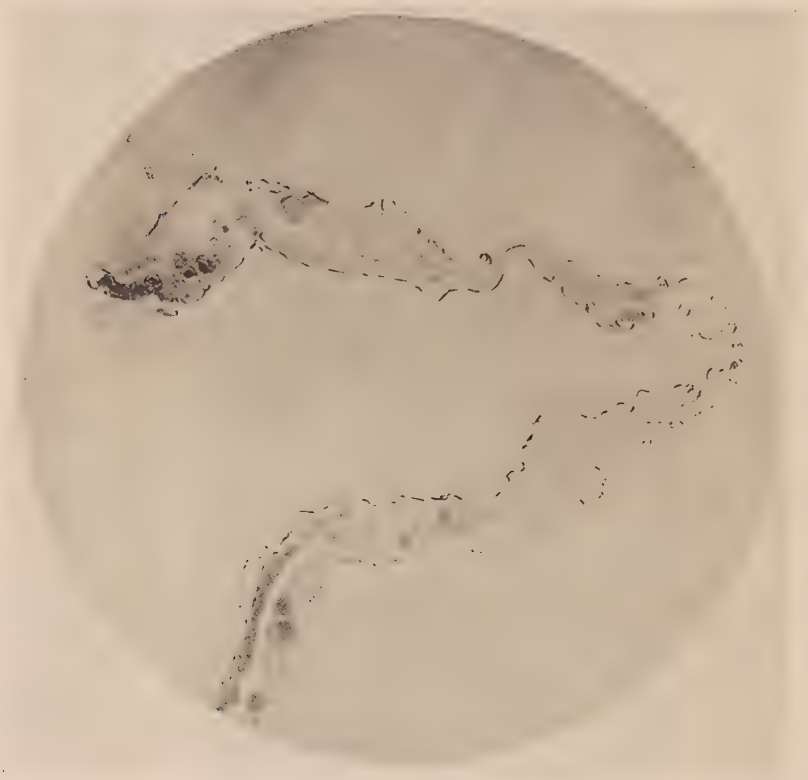

FIG. 19.—Case X. Photomicrograph at site of lesion. No cord tissue present.

CASE X.—Museum, No. 191, I.

A museum specimen with a somewhat scanty history attached. The patient was admitted to John Sealy Hospital with symptoms of a complete transverse lesion of the spinal cord at the level of the third thoracic segment. There was complete flaccid paralysis with absence of all reflexes and total anesthesia below

the lesion. The patient lived for several months. Bed-sores developed and severe cystitis set in before death.

The specimen (Fig. 18) shows a transverse crush of the cord with permanent flattening for a considerable distance. The flattened portion, which is as long almost as a vertebral body, is tape-like and consists almost entirely of pia mater. A microscopical

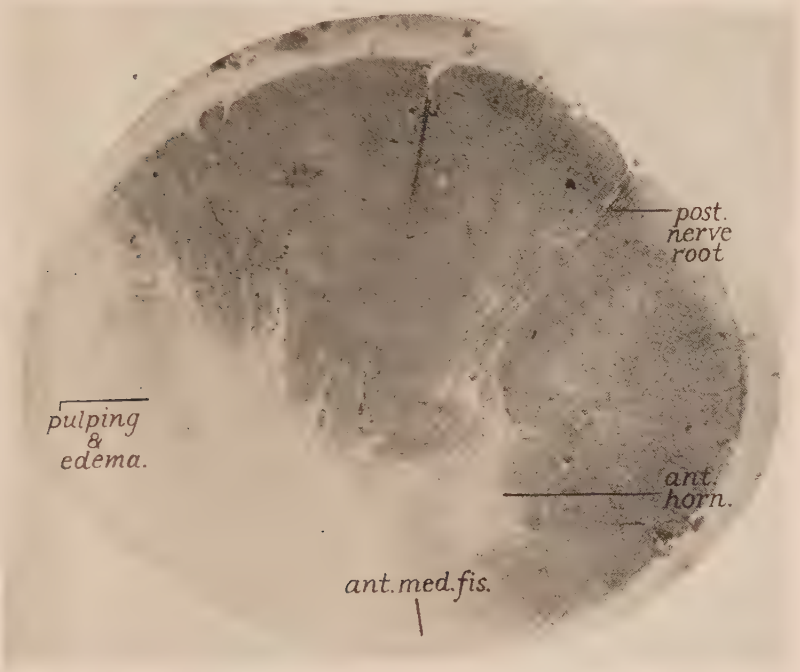

FIG. 20.—Case X. Photomicrograph showing pulping and edema above the crush.

section at this level (Fig. 19) shows merely granular debris and a few nerve roots surrounded by a sheath of pia. Immediately above and below the constriction the cord shows a bulbous enlargement. Sections through these areas show serious destructive changes. The section above the lesion (Fig. 20) shows complete destruction of the anterior cornu and the anterolateral portion of one side of the cord and partial destruction of the

anterior cornu of the other side. In the section below the lesion (Fig. 21) a similar but less extensive area is seen. Edematous areas are distributed throughout both sections.

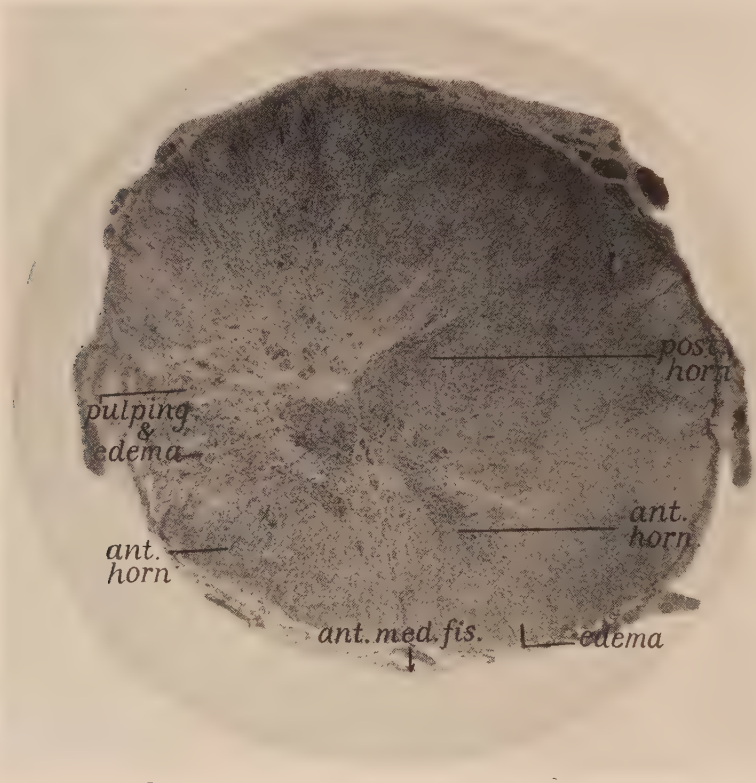

FIG. 21.—Case X. Photomicrograph showing pulping and edema below the crush.

CASE XI.—O. G. John Sealy Hospital, No. 39,013. Autopsy No. 723.

The patient fell into the hold of a ship and sustained a fracture-dislocation of the seventh thoracic vertebra, attended by symptoms of a total transverse lesion. He lived for fifty-one days and eventually succumbed to sepsis of the kidneys and bladder. No operation was performed on the spine.

At the autopsy there was a marked kyphotic curve in the mid-dorsal region. A fracture was found situated in the body of the seventh thoracic vertebra. The spinal canal was considerably narrowed at this level. The appearance of the cord is

FIG. 22.—Case XI. Dura, arachnoid and pia firmly adherent at the site of lesion; no cord tissue demonstrable here.

shown in Fig. 22. The cord was severely crushed and flattened over an area almost equal to two vertebral segments. The dura and pia mater were so firmly adherent that they could not be dissected away from one another without injuring the remains

of the cord. The cord was reduced to a narrow band of tissue of firm consistence contained in the tube of dura and pia. Several elongated narrow cavities which contained a grumous fluid are present in its substance. There were no signs of hemorrhage beyond a general dark staining of the crushed nervous tissue. The appearances are identical with those found at the time of operation in Case XIII.

Case XII.—B. M. John Sealy Hospital. History No. 956. The patient was admitted to John Sealy Hospital, March 4, 1920, totally paralyzed and anesthetic in his lower extremities, the result of a fall from a height of 20 feet. The eleventh and twelfth thoracic spinous processes were very prominent. X-ray examination showed a fracture of the body of the twelfth thoracic vertebra. Both legs were completely paralyzed and flaccid with complete absence of all reflexes. Anesthesia was complete to all forms of sensation up to a point on the front of the abdomen about 3 inches above the pubic symphysis and laterally to the level of the iliac crests. There was no control of the bladder and rectum. In time bed-sores developed on the buttocks, heels, toes and penis. There was no priapism. Death occurred four and one-half weeks after the injury from cystitis and renal sepsis. There was never any sign of return of the reflexes in the paralyzed limbs.

The autopsy showed forward displacement of the eleventh thoracic vertebra associated with a fracture through the body of the twelfth. The spinal canal was considerably narrowed. The spinal cord (Fig. 23) was completely crushed at this level and the crushed cord is represented by a flat tape-like band of tissue lying in a sleeve of pia mater. The pia mater was not torn. The dura mater was intact and was not adherent to the pia. Sections of the cord above and below the lesions showed pulping and cavitation similar to that seen in Case VIII, but more extensive.

CASE XIII.—J. R. John Sealy Hospital. No. 132,792. December 28, 1922, the patient was pinned underneath an overturned motor car. When extricated the lower extremities

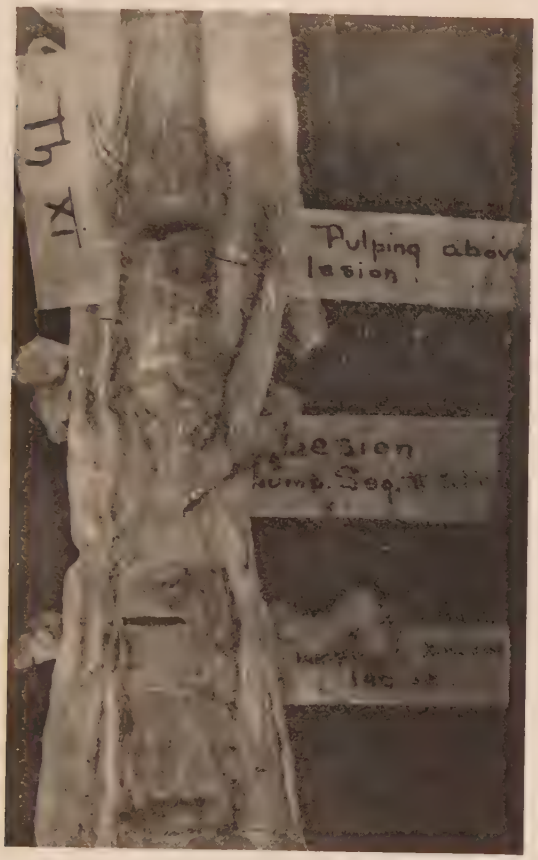

FIG. 23.—Case XII. Cord tissue squeezed up and down; empty tube of pia at site of lesion.

were completely paralyzed and he had lost control of the bladder and rectum. He was admitted to John Sealy Hospital, March 13, 1923. Examination showed that he was suffering from symptoms of a complete transverse lesion of the spinal cord below the

level of the twelfth thoracic segment. Sensation was present as low as the symphysis pubis in front and laterally a slight distance over the iliac crests. All the reflexes below the recti were completely lost. Bed-sores were present over the sacrum and heels. Urinary retention, which required catheterization at first, had now given way to dribbling. The bladder was not paralyzed but overflowed. It did not contract in response to tickling of the inner side of the thighs. Paralysis and anesthesia were complete in both legs. The muscles were flaccid and wasted. No reflexes of any kind were present. Anesthesia was absolute to every variety of stimulus. The skin was dry and scaly.

X-ray examination showed a dislocation forward of the twelfth thoracic vertebra on the first lumbar. The deformity was so excessive that the posterior edge of the body of the upper vertebra was in line with the anterior edge of the vertebra below. Under the skin of the back one could feel distinctly the upper articular process of the first lumbar.

The patient begged so earnestly for operation that I, against my better judgment, consulted to perform a laminectomy. I removed the laminæ and spinous processes of the eleventh and twelfth thoracic and the first lumbar vertebræ. The lamina and ligamentum subflavum of the twelfth thoracic and, to a less extent, those of the eleventh were firmly adherent to the dura mater. At the lower border of the lamina of the tenth thoracic the dura looked fairly normal. Underneath the lamina of the first lumbar the dura was also normal. The dura mater was opened in the middle line from end to end. The normal subarachnoid space was opened above at the lower border of the lamina of the tenth thoracic. The dura was quite adherent to the pia opposite the body of the eleventh and densely adherent opposite the body of the twelfth. Opposite the first lumbar the subarachnoid space was not obliterated, but it contained very little fluid. While trying to separate the adhesions between the dura and pia opposite the body of the twelfth thoracic a cystic cavity about $\frac{1}{2}$ inch long was opened from which flowed a

turbid fatty-looking fluid like pus. The cystic cavity occupied the middle of the flattened band of tissue which represented the crushed cord. It was unrecognizable as nervous tissue. Over an extent of almost two spinal segments the cord had been destroyed. The lumbar enlargement was recognizable but somewhat smaller than normal.

As far as could be ascertained by the naked eye the cord was completely destroyed opposite the body of the twelfth thoracic vertebra. Nothing had been gained by the operation, as was surmised beforehand. Since the operation no change whatsoever has occurred, either in motion or sensation, or the return of reflexes.

Remarks. All the cases in this group had lived a considerable time since the accident. We are uncertain about the exact time in Cases VIII and IX, but from the appearance of the soft tissues in Case VIII and from the autopsy notes in Case IX, several months must have passed between the history and death. Marked cavitation is seen in Case VIII, and the conical areas of disintegrated tissue show up clearly. Permanent narrowing of the canal had resulted, in Cases IX, X, XI and XII, from failure of the vertebræ to recoil. In each of these cases continuous pressure had molded the crushed cord into a flattened tape-like mass or had forced it completely out of the sheath of the pia mater. It seems probable that soft diffluent cord will flow backward into the sheath of the pia mater as soon as pressure is relieved by recoil of the bones, but that continuous pressure, such as exists where the deformity is permanent, will produce permanent flattening. In Case VI diffluent cord had refilled the tube of pia from which it had been squeezed. Nevertheless it was disorganized completely, and for a considerable distance above and below the lesion cavities filled with blood and disintegrated nervous matter were found. If the sheath of the pia mater is torn diffluent material will frequently flow out of the pial sheath into the subarachnoid space. In such cases, if the dura mater is opened at operation or at autopsy,

the diffluent disintegrated cord tissue will ooze out of the opening. The microscopical appearance of sections taken through the crushed area shows fissures which traverse the cord substance in the direction of the exit of the pulped tissue through the torn pia mater. The arrangement of the diffluent cord in parallel areas also suggests lines of flow or currents. Such appearances are shown in Figs. 7, 24 and 25.

In Case XIII we had an opportunity of seeing at operation a crushed cord identical in most respects with those described in Cases IX, X and XI. A period of a little more than three months had passed since the injury, and during this time the disintegrated nervous tissue had liquefied and lay in a cavity situated in the flattened band of tissue representing the crushed cord. It showed convincingly the futility of operative interference, because there was not a shadow of doubt that the destruction was absolute. The most hopeful and sanguine surgeon could hardly have persuaded himself that relief of pressure would produce a beneficial result.

By the courtesy of Adjunct Prof. Joseph F. McVeigh, of the department of anatomy, I am able to show the spinal cords of several dogs which had been crushed experimentally with a view of causing a lesion as near as possible like that which would follow a fracture dislocation. In each experiment the cord was exposed by nibbling away the spine and laminæ of one or two thoracic vertebræ. Through the intact dura mater the cord was crushed either with the tip of a finger or the handle of a scalpel. In some of the experiments pressure was continued until the finger or handle of the scalpel was arrested by the vertebral bodies. In others less severe force was used. No attempt was made to measure the force employed, because the object of the study was merely to observe the changes that resulted in the traumatized zone and in the contiguous areas. We found in all cases that the changes were identical with those seen in human cords. The production of cone-shaped areas of destruction above and below the lesion when the crush was complete, the widespread hemorrhagic extravasation, the lique-

faction of the disintegrated nervous tissue and the production of cavities were all observed. Morevoer, we were able to follow the separate steps of the degenerative changes because the regulation of the age of the morbid processes was completely under our control.

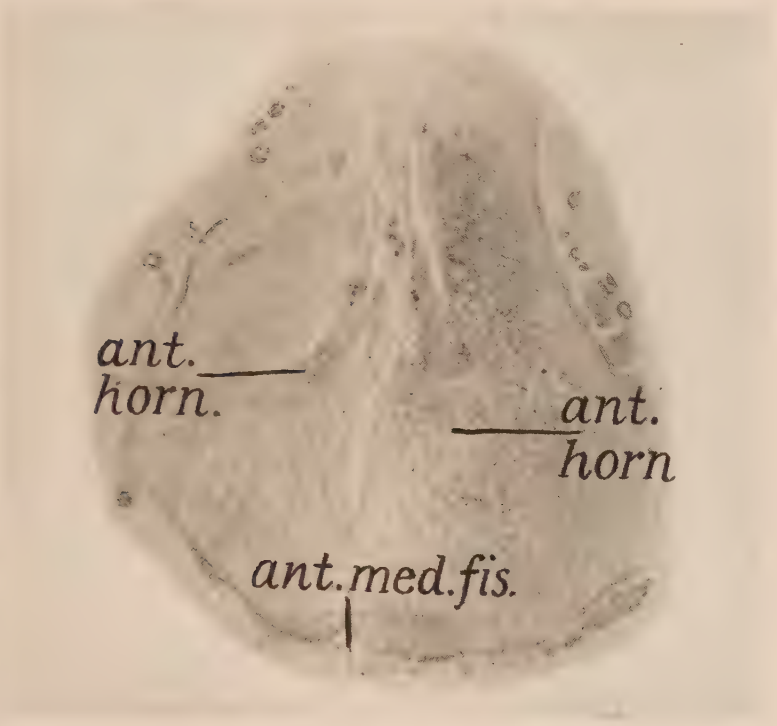

FIG. 24.—Dog, killed thirty-two hours after partial crush. Cord tissue flowing toward opening in dura.

In Fig. 24 (dog 6) a curious distortion of the posterior half of the cord has occurred. The section was taken at the level of a crush in which only slight force had been employed. A slight opening had then been made in the dura mater through which clear cerebrospinal fluid flowed. The dog was killed thirty-two hours afterward and up to the time of death the hind

legs were completely paralyzed. The section shows that the posterior surface of the cord is drawn out somewhat like the stem end of a pear. The posterior columns and cornua are seriously broken up, and seem to be flowing backward in lines resembling currents of lava. The appearances suggest strongly

FIG. 25.—Dog, killed forty-one hours after the crush. Section above the lesion.

that the flow of disintegrated tissue is toward the hole in the dura mater which was made at the time of operation. The same appearances are shown in the human cord described in Case IV.

In Fig. 25 (dog 1) a considerable degree of force was used

by the tip of the finger. The dog was killed at the end of forty-one hours. The specimen taken through the lesion shows an excessive degree of pulping. It occupies all the posterior columns and the adjacent parts of the posterior horns and the gray commissure. Wide, branching fissures extend in every direction between masses of disintegrated tissue. There is

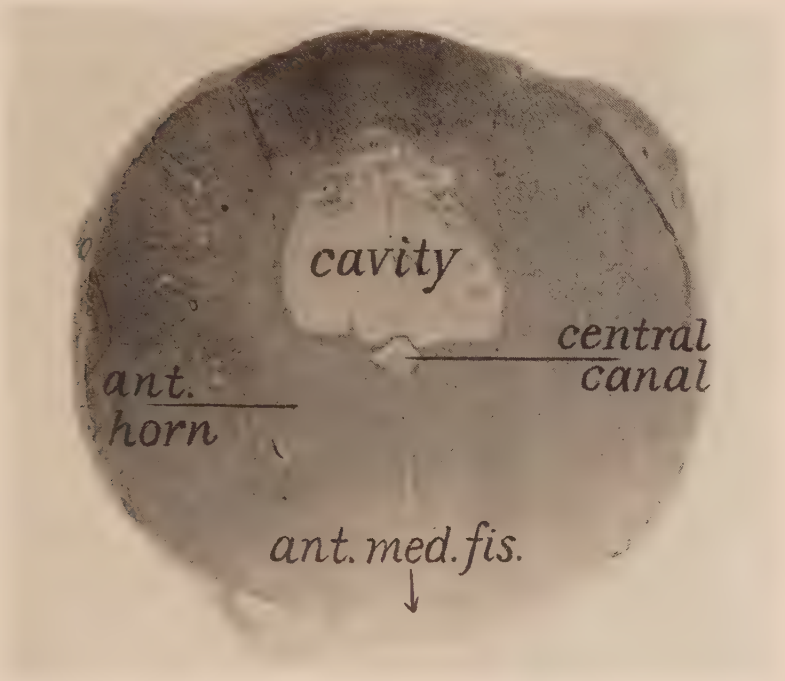

FIG. 26.—Dog, killed two weeks after the crush. Cavity above the lesion.

marked edema in every other part of the section, particularly intense at the periphery of the lateral columns. The pulped area is permeated with extravasated blood and is a transverse section of the cone previously described. It is so completely cut off from the unshattered part of the cord which surrounds it that liquefaction and cavitation would probably have resulted if the dog had lived long enough.

In Figs. 26 and 27 (dog 2) we are able to show the later changes. The dog was killed at the end of two weeks. The cone-like area of destruction has undergone liquefaction and absorption resulting in cavitation. The cavity is situated in the posterior cornua abutting on the gray commissure. The appearances are identical with those shown in the human cord in Case VIII.

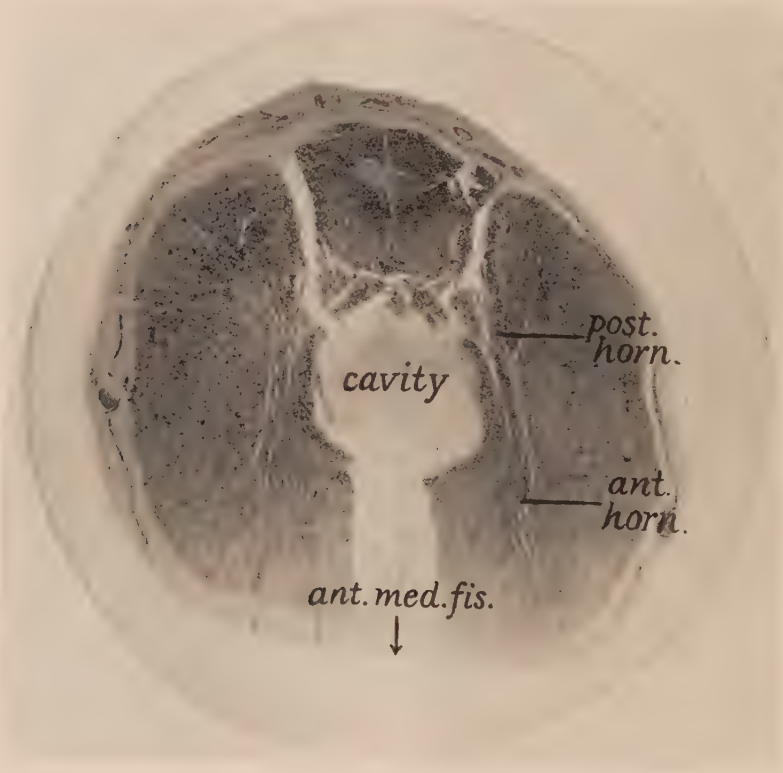

FIG. 27.—Same dog as Fig. 26. Section below the lesion. *Cf.* Fig. 16.

In Fig. 28 (dog 5) a moderate degree of force was used with the handle of a scalpel. The dog was killed at the end of twenty hours. The distortion is great. Hemorrhage is present in both anterior cornua. The cord resembles closely the human cord in Case III.

In undertaking this study I was anxious to find out if the area of destruction of nervous tissue was absolute from the moment it occurred or whether it was progressive; in other words, whether morbid changes occurred in the neighborhood

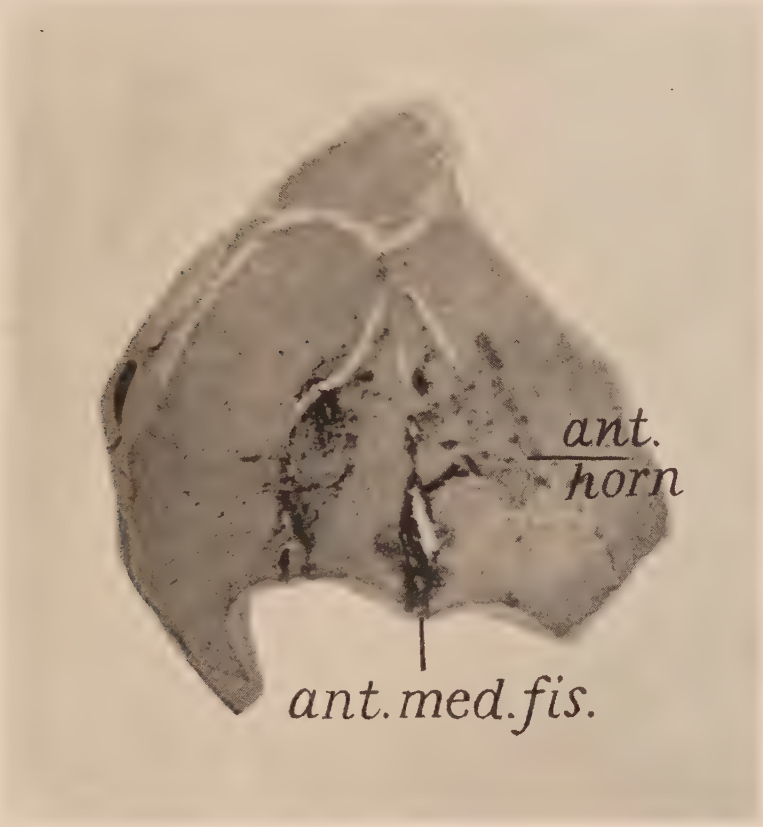

FIG. 28.—Dog, killed twenty hours after partial crush. Deformity and hemorrhage at site of lesion. *Cf.* Fig. 5.

of the extravasations of blood which would ultimately lead to the death of nervous elements which were unhurt originally; and, further, if such changes occurred, whether it was possible to arrest them by operative procedures. It is unnecessary to

discuss the question of regeneration of axis-cylinders and the other intrinsic nervous elements of the cord, because no evidence has ever been advanced either from a pathological or clinical standpoint to support such a belief. We must accept, finally, the statement that regeneration never occurs.

Touching the question of progressive destruction, it is a very difficult matter to arrive at a sound conclusion, because the changes that occur are of an entirely different character to those met with after injuries of other structures of the body. The phenomena of active inflammation which always occur during the healing of gross tissues are never seen. There is nothing that resembles, in the least degree, the circulatory and cellular changes which are present in tissues undergoing repair. The processes, on the contrary, are of a passive nature, consisting of edema followed by liquefaction and vacuolation. Edema seems to occur inevitably, sooner or later, in or around the areas of extravasated blood. We found it present, to a limited degree, in one of the dogs at the end of eight hours. It was always present in dogs who survived the crush for twenty-four hours. In our human cords, however, we found that it was absent in Case III, who lived twenty-four hours, and in Case IV, who lived about forty hours. In all the cords of patients dying at a later date, edema was seen in every part of the section, more intense in the areas of extravasation of blood; and, where life had been prolonged for several weeks, clearly demonstrable in the periphery of the cord. The significance of edema is not clear. Some writers, such as Frazier and Allen, believe that it is the direct result of circulatory changes produced by ruptures of small arterioles, and that it is essentially progressive and destructive in its tendencies; in other words, that nerve tracts that have escaped destruction by the primary injury may be destroyed later on by edema.

The experimental observations of Allen on the changes following contusion of the spinal cords of dogs led him to believe that the extravasations of blood occurring in the substance of the cord and under the pia mater were progressive to a certain

point and that edema made its appearance in the substance of the cord in fifteen minutes. An incredibly short time! He believed that hour by hour disruption of the cord progresses, aided by hemorrhage and edema and that the condition of the injured segment is very much worse three or four hours after the accident than it is, say, at the end of the first hour. From these observations he concluded that if the secondary changes in the cord, namely, edema and hemorrhage, could be prevented, many cases of total transverse lesion could be averted and partial recovery of function secured. To this end he advised an incision of the cord through the contused level to drain away the effused blood and relieve the intramedullary pressure. The incision employed was carried longitudinally through the injured segment exactly in the middle line of the cord, separating it into two halves. He found in cords subjected to this incision, two hours after being crushed by a force which had been standardized so as to produce a complete transverse lesion, that he had been able to arrest the disintegration of tissue such as invariably occurs in non-operated cases. The experimental work on which these conclusions are based was carried out so accurately that the deductions are apparently logical and justified. It is difficult, however, to accept them unreservedly for two reasons: (1) Because paralysis and anesthesia reach their maximum immediately after the injury and are seldom of the progressive type and (2) because the changes seen in a crushed cord after incision are open to an entirely different interpretation.

The first objection is on clinical grounds. It is true that we occasionally see cases in which paralysis and anesthesia are progressive, but they are the exception and not the rule. The following are examples: We have recently had under our care a patient whose motor paralysis pointed to a transverse lesion of the cord at the level of the seventh cervical segment. Sensation to pin-prick was present in isolated areas distributed irregularly over the chest, abdomen and legs. The superficial abdominal reflexes were present but the cremasteric was absent. All the deep reflexes of the leg were absent. There was no

fracture of the spine and no deformity of the spinal column. The cord symptoms followed a severe contusion over the seventh cervical spine. A few days after admission the areas of sensation and the superficial reflexes disappeared and the upper limit of anesthesia became definitely fixed. No change occurred afterward up to the time of death. We have also histories of several cases of complete transverse lesions resulting from fracture-dislocation associated with deformity in which the loss of motion was instantaneous, but sensation was not lost until later (Case V). Another patient, whose sixth cervical vertebra was dislocated forward during a football game, asserted that he felt distinctly the pain caused by the forcible ripping of strips of adhesive plaster from his insteps when his shoes were removed.

Nevertheless, in complete transverse lesions, paralysis and anesthesia are usually definitely defined immediately after the crush. There may be some difficulty for a day or two in outlining accurately the upper limit of sensation by reason of the profound spinal shock or the fact that the lesion is not linear but diffused over several segments; but, when spinal shock disappears the limits of paralysis and anesthesia become definitely and permanently fixed. In partial lesions there is frequently a period during which spinal shock is so profound that the injured segment is unable to transmit any impulses through it. Such cases are often mistaken for examples of total transverse lesion until the return of function shows that some tracts have escaped destruction. Far from noticing signs of progressive destruction in such cases, recovery up to a certain point is smooth and uninterrupted.

The second ground of objection deals with the proper interpretation of the changes seen in a contused cord after a median incision. In his original article, Allen shows transverse sections of two injured cords. In one (Fig. 1) no incision had been made and the cord was removed six hours afterward. In the other (Fig. 2) a median longitudinal incision had been made two hours after the injury and the cord removed four hours after the incision. The first cord (not incised) shows extensive destruction of both

the posterior cornua and both posterior white columns. The pia mater is intact and the general shape of the cross-section is not much changed. The injured area for the most part is composed of disintegrated diffluent matter very loosely connected with the firmer uninjured nervous tissue surrounding it. The second cord (incised) is considerably flattened laterally. Both posterior horns are missing and the space occupied originally by the posterior columns is almost obliterated by the collapse of the lateral columns toward the median line. A pyriform cavity apparently filled with blood occupies the unobliterated part of this space. The incision into the disintegrated area appears to have relieved pressure and to have allowed the diffluent material to escape. This has evidently been followed by collapse of the cord and approximation of the lateral columns, resulting in a decrease in the lateral diameter of the cord. There is no doubt that the substance of the cord is clearer and better preserved in the incised than in the non-incised specimen, but there is such a decrease in the transverse area of the cord that we cannot help feeling that the diffluent tissue which escaped from the incision carried with it a considerable amount of nervous tissue which was not seriously injured and which might have been expected reasonably to have recovered if it had not been disturbed.

We have previously pointed out, both in human and dogs' cords, that the area of disintegrated material is cone-shaped and that the apices of the cones are situated at a considerable distance above and below the level of the lesion. The cones consist of diffluent material, the quantity of which is quite considerable. It forms the thick, creamy material which flows out of the pia mater when the cord is exposed. While it lies in the substance of the cord it acts as a support to the uninjured tissue surrounding it. Evacuation removes the support and the walls of the cavity cave in like the sides of a sand pit or the banks of a river when the waters recede. On these grounds we believe that evacuation is not without its drawbacks and dangers.

Even admitting that incision usually produces the beneficial results claimed for it experimentally, we must not forget that the method employed to crush the cord of a dog injures the posterior columns more frequently than any other part and that they occupy the only really accessible part of the cord. On the other hand, it is impossible to drain the anterior and lateral regions of the cord through a median posterior cut, and we have found these areas not infrequently crushed in human cords. (See Cases III and IX.) Allen himself emphasized the fact that the progressive destructive changes reached their maximum in about four hours and that after this time the picture did not change materially. Therefore, it follows that the crushed cord must be incised immediately after the injury if we are to expect beneficial results. At the end of four hours the mischief would be complete and incision would then be futile. One can imagine that a procedure hedged around with such restrictions must have a very limited field of usefulness.

At the present time there seems no probability of agreement as to whether operation is either advisable or justifiable. Some surgeons believe that operation should be performed in every case as soon as possible in the hope of finding some condition such as hemorrhage or deformity, the removal of which will prove of benefit to the patient. Others never operate under any circumstances because they believe that it is useless to expect the injured cord to recover. Extreme views are seldom wise. The middle course is always safest (*in medio tutissimus ibis*). I have personally for many years been strongly opposed to operation as a routine procedure. It is often unsafe, rarely justifiable and usually futile. Except in the rare instances where median incision of the cord is the objective, mere exposure of the injured segment is all the surgeon can hope to accomplish, because deformity is seldom persistent and massive hemorrhages do not occur. I believe that the only positive indication for operation is the persistence of deformity of such a degree as to justify the assumption that the cord is subjected to pressure. Even with such strict limitations incomplete lesions alone

would be benefited. If it were possible to distinguish with certainty, complete from incomplete transverse lesions in the early period, the problem would be solved. At the present time we are unable to decide, and consequently we must either wait days or weeks for unequivocal signs or operate early in the hope of affording relief. I firmly believe that waiting is the best and safest course.

References

Allen, A. R.: Journal of Nervous and Mental Diseases, March, 1914.

Ibid: Journal of American Medical Association, September, 1911.

Frazier, Charles H.: Surgery of the Spine and Spinal Cord.

Horrax, Gilbert: British Journal of Surgery, July, 1919.

Thorburn, William, and Richardson, George: British Journal of Surgery, April, 1919.

Thorburn, Sir William: British Journal of Surgery, October, 1920.

Ibid: A Contribution to the Surgery of the Spinal Cord, 1889.

AN ANALYSIS OF 755 CASES OF NEURALGIAS OF THE FACE, WITH RELATION TO PAIN AND OTHER SENSORY PHENOMENA BEFORE AND AFTER OPERATION

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(By Invitation.)

In daily contact with patients who suffer from pain in the face and head, one's attention is at once drawn to the extraordinary variety of subjective sensations in this region assembled under the generic term pain. Much of the surgical literature of trigeminal neuralgia of recent years has to do with matters relating to operative technic. The radical operation upon the sensory root, as first proposed by Spiller in 1899, is now universally accepted and its technic perfected, and we have turned our attention to other phases of the subject and propose in this contribution to present an analytical review of the sensory phenomena before and after operation in typical and atypical cases. It is not so much our purpose to discuss the anatomical or physiological evidence of the various phenomena as to present the various clinical syndromes of the material at our disposal. The term "major trigeminal neuralgia" is employed as synonymous with "tic douloureux," "epileptiform neuralgia," recognized as a distinct clinical entity and contrasted with other neuralgias in the same territory which will be designated as "atypical." For the purpose of our discussion we have reviewed

our records of 755 cases, the material at our disposal including the following:

I.	Major trigeminal neuralgia upon which the radical operation has been performed	301
II.	Major trigeminal neuralgia treated by alcoholic injections	210
III.	" " " " by peripheral operations	35
IV.	" " " consultations	145
V.	Atypical neuralgias, treated	35
VI.	" " untreated	29
	Total	755

In addition to these 755 clinical records, we have had at our disposal the information in 327 questionnaires recently received as follows:

From patients after the radical operation	200
" " " alcoholic injections	92
" " " peripheral operations	11
From atypical cases	24
Total	327

From these several sources of information we present the sensory disorders in three categories:

I. The pain phenomena of the major trigeminal neuralgia before operation or alcoholic injection.

II. The distortion of sensation after operation or alcoholic injection.

III. The pain phenomena of the atypical neuralgias.

I. *Preoperative Pain Phenomena in Major Trigeminal Neuralgia.*

We have attempted in our clinical records to describe the pain in the patient's words, and attention is called particularly to the great variety of sensations, thus expressed, given in order of frequency:

shooting	boring	cutting
sharp	tearing	grinding
paroxysmal	stabbing	twisting
burning	lancinating	squeezing
lightning	stinging	smarting
hot iron	twitching	piercing

From this great variety of descriptions is it possible to establish any classification as to the varying types of sensory disturbance in the trigeminal tract? Are these terms descriptive in the sense that one could speak of disturbances of pain, thermal or tactile sense as one might differentiate the sensory disturbances of a peripheral nerve or a lesion of the spinal cord? Most of them imply a sudden, paroxysmal pain with interruptions or remissions, the type of pain we are accustomed to associate with major trigeminal neuralgia. In this category we might include shooting, jumping, twitching, lightning and lancinating. But there is a group in which the description of the pain implies a disturbance of temperature sense, such, for example, as burning, hot iron, smarting or stinging. Some indicate a sensation characteristic of a sharp instrument, stabbing, cutting, sharp, pricking or piercing. Others again may be with some latitude of interpretation regarded as evidence of pressure sense disturbances, boring, grinding, squeezing or drawing. We began the review of these tables of sensory manifestations without any preconceived notion as to classifications, at first merely being struck by the array of descriptive terms; but in an attempt at analysis we find at least three different types of sensation: (1) *Pain* sensation (using the term in its descriptive sense as opposed to other forms of sensation such as tactile, thermal, pressure); (2) *pressure* sensations, and (3) *thermal* sensations. Presumably it is reasonable to postulate that in a lesion of any sensory nerve there may be disassociation of sensation, so that it is not surprising to find in a lesion of the trigeminus these varying expressions of disturbed sensation, classified as they have been under pressure, thermal and pain.

It would be a paradox were we to find in these neuralgia syndromes any expression of disturbance of tactile sense, the only remaining form of disassociated sensation, such as might be expressed by the patient in terms of numbness, and yet one wonders if this be represented as a part of a sensory nerve function, why it should in all cases be excluded. As these various types of pain are observed as subjective disturbances,

it is also true as a corollary that under certain conditions, as, for example, in tumors of the ganglion, or after alcoholic injections, one finds objective disturbances of tactile sensation just as one does for heat or pain.

With the wealth of material and the abundance of opportunity one might hope to find a clue as to the etiology of major trigeminal neuralgia, but our thoughts are still speculative. Scanning the field for analogies, one's attention is attracted to the crises of tabes as more nearly simulating in character and intensity the pain of neuralgia of the trigeminus. In fact, there is no other painful affection other than the tabetic crises so closely akin to the pain of tic douloureux, especially in its lightning-like paroxysmal character But with the tabetic crises there is an associated pathological lesion. Such has never been found in the major trigeminal neuralgia. The whole trigeminal tract, the ganglion and its three divisions (through the ciliary, Otic and Meckel's ganglia) are supplied by the sympathetic system. Whether by the induction of an anemia, through its vasomotor control the sympathetic system plays an indirect role, in the etiology of these paroxysmal neuralgias, is an interesting question.

II. *Distortions of Sensation after Operations or Alcoholic Injections.*

The behavior of the patient after the relief of the pain of major trigeminal neuralgia by the radical operation or by alcoholic injection is a subject that has commanded our attention. It has been our practice before the operation to warn the patient that after the operation the face will be numb always. He or she must be willing to exchange numbness for pain. This seems perhaps a trivial matter, but when one may be in doubt as to whether the patient has the major neuralgia, whether the pain is as intense as the patient has led us to believe, when told that numbness will be permanent after the operation, the patient makes his or her own diagnosis. If the patient shrinks at the thought of numbness and hesitates, it is not the major neuralgia. The patient makes the decision for you. A sufferer from true

trigeminal neuralgia is willing to make any sacrifice to be relieved of pain. Such is its intensity.

So one of the sensory after-effects of operation is numbness; not only does the face feel numb immediately after, but also swollen. You ask the patient how he is the day after operation, and he tells you his lip is swollen or his tongue is thick. These are the common every-day observances. But in the vast majority of cases the patient gradually becomes accustomed to the new order and is grateful for the relief of pain, giving no further thought to these anesthetic sensations.

Later on a minority will observe other sensory phenomena which give to some much and to others little concern. This difference in the reaction of the patient to what we will call paresthesias is very striking, and we have ascribed the difference to the stability or rather the instability of the nervous system at the time of operation. There is no doubt that some patients, as a result of prolonged pain, suffer nervous exhaustion. Through depression or exhaustion the central nervous system loses its inhibitory control over afferent impluses. In these the post-operative paresthesias may run riot. In some cases the patient will acknowledge these paresthesias to be of no consequence, in some they may become an obsession. It is also true in this postoperative period that in the majority, as time goes on, the paresthesias are a matter of less and less concern and within a year may disappear. Questioning a patient operated upon five years ago, he told me that he had had a burning sensation in the mouth ever since the operation, but that he had grown accustomed to it, and except when tired he was not conscious of it.

To what these paresthesias may be due is an interesting question. Pain referred to the periphery after the removal of the conveying afferent pathways is commonly observed after amputations, and so after section of the sensory root one may, as the result of irritation of the central segment, postulate sensation referred to the peripheral distribution of the trigeminus. In support of this hypothesis we cite the case of one of our

patients, who, after section of the sensory root, continued to complain of all sorts of sensations in mouth and face. It was afterward discovered that he had a tumor of the posterior fossa, pressing upon the central segment of the sensory root. Possibly the cicatrization about the root after the operation is the source of irritation, but whatever the cause, it is extraordinary how varied in character, expressed in the terms of the patient, these paresthesias may be. As before the operation we were able to classify the various pain phenomena, according to whether they represented temperature, pressure or some other form of sensation, so these postoperative paresthesias seem to permit of grouping. Leaving out of consideration numbness, the most common, some might be classified under *temperature disturbance* and are described as a sense of burning in the face or mouth, a sense of cold and a sense of warmth. In 3 cases the mouth was hypersensitive to cold.

Others again might be classified as indicating *disturbance* of *pressure sense*, tightness, pressure, drawing, gripping, stiffness, dulness, pulling; a few as indicating *pain phenomena*, such as stinging, prickling, soreness; and others with varied kinds of *surface sensations*, crawling, creeping, itching, tingling, swelling. Relatively frequent is what may be described as a painless impulse. Following the course traversed by the pain before operation, the patient experiences the sensation of an impulse wholly without pain. Sometimes it is a source of alarm, suggesting to the patient regeneration of the affected nerve and a possible forerunner of recurrence. Many times have we had to assure the patient that this sensation was of no significance. In a few instances there have been subjective sensations, suggestive of a sympathetic origin, a sense of dryness of the eye or nose, rhinorrhea, lacrimation and salivation. Four patients experienced a sense of irritation of the conjunctiva.

While in the aggregate there appear to be numerous instances of paresthesias, as a matter of fact they are the exception. A number may be combined in a single case. If a given case complains of one form of paresthesia, he is likely to complain of a number.

The paresthesia of which there is greatest complaint, and perhaps the commonest, is burning. If a patient complains at all of the after-effects of the operation, almost invariably it is because of burning. Why this should be so is one of the conundrums in this research, and why this burning should be almost invariably in the second and third distributions is equally puzzling. Looking for a parallel condition in other nerve tracts, we were reminded of the burning sensation in the causalgias of the median nerve and of the relief afforded by the Leriche operation upon the periarterial sympathetic plexus. With this in mind we selected from our series a patient who complained of a burning sensation in the gums, a sense of pins and needles in the face and a burning sensation in the cheek below the eye. With a view of determining what effect a sympathectomy would have the superior cervical sympathetic ganglion was removed and the periarterial sympathetic plexus stripped from the common carotid artery on the affected side. The operation relieved the burning in the cheek and the dry feeling of the eye disappeared. What the significance of this single observation may be one dare not conjecture. It arouses our curiosity, however, and focuses our attention again on the possible relationship of the sympathetic system as a factor in the neuralgias.

III. *The Pain Phenomena of the Atypical Neuralgias.*

When consulted by a patient with neuralgia of the face one's first concern is the differential diagnosis. Has the patient major trigeminal neuralgia or has he not? As a rule, the differentiation is not difficult, but that mistakes may be made our own experience testifies to. In the 301 major operations there were, judging from the events subsequent thereto, possibly 19 atypical cases. This differential diagnosis is a matter of great importance, for should a mistake be made, not only will the patient not be relieved by the operation, but the last state of that patient in all likelihood will be worse than the first. The atypical case will complain of numbness and other

paresthesias after the operation as much as of pain before, or should the pain be relieved in one place after the operation it will be referred to another. In some instances the mistake may be pardonable. As the symptoms are all subjective, the patients' story and description are the only available criteria. If the description simulate that of major trigeminal neuralgia an error in diagnosis may readily be made. In one of our earlier cases the patient complained as much of pain immediately after as before the operation. Five days later the wound was reopened and, though not under the influence of a general anesthetic, the patient experienced no pain whatsoever when the ganglion was crushed in the grasp of a hemostatic forceps. Evidently the case was "atypical."

One wonders sometimes whether it is proper to speak of these atypical cases as neuralgias. Neuralgia implies specifically the sense of pain. What do we conceive specifically as pain? Any local stimulus may cause discomfort. Localized pressure may cause discomfort, but if steadily increased the sensation may become more and more uncomfortable until justly it may be called pain (Head). Thus we must recognize transition stages between discomforts and pain and by what means to differentiate them sharply is a question. Some of these so-called "atypical" neuralgias are on the border-line.

Upon what may a differential diagnosis be established between the "major" and the "atypical" neuralgias? The inquiry should be directed toward the character, the zone of distribution, the intensity and constancy or intermittency of the pain phenomena. We have analyzed critically a series of 60 cases unquestionably atypical, and the following observations were made as contrasting the atypical and typical forms.

1. *Distribution.* (*a*) As to the zone involved, the pain is not referred to the peripheral distribution of the nerve, that is not to the teeth, lips, chin, ala of nose; rather to the cheek, temple, orbit, in front of or behind the ear, occasionally to the jaws. (*b*) The pain does not radiate along the course of one or the other nerve tracts. It seems unrelated to any anatomical

distribution. It will jump across from one zone of one of the three divisions to another, but never to the periphery. (*c*) The pain extends beyond the trigeminal territory; behind the ear, to the submaxillary region, to the shoulder and arm.

2. *Character.* In the majority of cases the pain is described as drawing or pulling. The thought of pressure disturbance seems dominant; the tissue or the region feel as though under tension; this seems especially characteristic; or the pain may be described as burning, as an ache, sometimes boring or throbbing, rather than cutting, stabbing or tearing. It is almost always deep-seated, deep in the orbit, deep in the cheek or temple, not superficial or terminal, and what is particularly noteworthy, it is constant and not intermittent or paroxysmal, though varying in its intensity. It is relieved by opium and is often quite as bad at night as by day. Briefly there are these distinguishing features. An illustrative case may be cited:

Mrs. C. F. L., aged fifty-two years. Complains of pain in the right side of the face. The pain is constant at morning, noon and night, and is a "solid, genuine ache." There is a tremendous burning and a sensation as if the eye were being pulled out. The distribution is in, within and about the eye, aud in the back of the neck, and extends to the shoulder. In addition to the constant aching pain there are more severe paroxysms lasting two to three hours and requiring for relief morphine or codeine by hypodermic. Cold, talking, chewing and fatigue all have a tendency to aggravate the pain. For the relief of the intense suffering before she consulted us, various sinus operations had been performed and two exploratory operations for brain abscess. An alcoholic injection in the ganglion given in another clinic made her worse rather than better.

Bearing in mind the characteristic features of atypical neuralgia as above outlined, one may be able to avoid mistakes in the majority of instances. Occasionally we yielded to the patient's appeal for relief and operated in doubtful cases because of the intensity of the pain, disregarding other atypical phenomena.

Certain it is that we have no positive information as to the etiology of the typical major neuralgia. What of the atypical neuralgias? In reviewing the atypical cases we have kept in mind the sphenopalatine ganglion as a possible factor, but we have been unable to recognize any symptom-complex which would justify the recognition of such as a distinct clinical entity, as Sluder suggested. In fact, it is difficult to find enough similarity in the atypical neuralgias to justify any classification. The diversity of the clinical picture is one of the outstanding peculiarities. In only the exceptional case did cocainization of the sphenopalatine ganglion—one of Sluder's diagnostic signs—have any influence upon the pain. In one case, where a provisional diagnosis of sphenopalatine neuralgia was made, the removal of the sphenopalatine ganglion did not give entire relief.

Whatever may be the significance, we have been struck with this fact; comparing what we called paresthesias, exhibited in some cases of major trigeminal neuralgia after operation, with the sensory phenomena of the "atypical" group, we have noticed a similarity in the descriptive terms. On the one hand we see a patient, exceptional to be sure, after the major operation for the relief of major trigeminal neuralgia, though having total anesthesia in the trigeminal distribution, experience a sense of burning or pressure or tightness in the face or mouth. On the other hand, we see a patient not operated upon, stamped as an "atypical" neuralgia, experience the same sensations. Out of these contrasting phenomena some constructive thoughts may come as to the nature of these peculiar sensory complaints. To speak of them as "atypical" merely begs the question.

PERIARTERIAL SYMPATHECTOMY

By GEORGE P. MÜLLER, M.D.
PHILADELPHIA

In 1913, Leriche described the operation of periarterial sympathectomy, and in 1921, before this Association, he reported the results of 64 cases. In all he has published twenty contributions on the subject. It is the object of this paper to place before you the results obtained in 26 sympathectomies on 22 patients.

The technic of the operation is simple. The artery, usually the brachial or femoral, is exposed for a distance of about 10 cm. and the adventitious layer carefully peeled off. At once a contraction of the manipulated artery occurs and presumably continues for a number of hours. In my cases this always occurred in the brachials, but about one-third of the femorals failed to contract, and of these all but 1 case had a diseased artery. The symptoms of the ischemia, as described by Leriche, in my series were not so pronounced, but several patients reported that the pain was worse after operation, and in 1 case, where the artery was slow to contract and the stripping proceeding painlessly, the patient experienced extreme pain in the foot when the artery contracted. After several hours, Leriche says three to fifteen, the secondary phenomena appear and indicate dilatation. They are:

1. An elevation of local temperature. In most of our cases we have thought that the operated side was the warmer on the day after operation, but in several cases where skin thermometers were used the results were inconstant and variable. Lehman,

in 1923, working on the dog, has been unable to verify this rise in temperature and suggests that the "wound factor" may be a partial cause for the findings of Leriche. Much stress has been laid on this point because the temperature of the skin is determined primarily by the rate of bloodflow which, in its turn, depends upon the degree of contraction of the arteries and arterioles. An increase in warmth would indicate an increase in the current of warm blood flowing through dilated arterioles and capillaries. An increase in the color of the skin indicates dilatation of the capillaries. If red, the blood is flowing rapidly. If blue or cyanotic, the capillaries are still dilated, but the current is slow and the blood has lost more oxygen than usual. I thought this might offer a better index than the measurement of skin temperature, and in 1 case we took samples of blood just before and after manipulation of the artery. The results were suggestive, although contraction was very slight. Dr. Kornblum, of our Clinic, working from the Department of Research Medicine, then studied the oxygen content of the venous blood in volumes per cent in 4 of the patients.

The first case studied was one of trophic ulcer of the foot, and the test showed:

Before operation	13.9	volumes per cent	O
After stripping	12.4	" "	O
Two days later	11.9	" "	O
Six days later	14.0	" "	O

The trophic ulcer healed in five days except for complete epithelialization. The result in the second case was also satisfactory. The patient suffered from painful trophic contraction and edema of the lower extremities following a polyarthritis. The test showed:

Before operation	9.2	volumes per cent	O
Two days after	12.8	" "	O

The later tests were very disappointing—in 1 case the O content was actually increased (7.35 to 8.35) after manipulation

and in the other the volume per cent was 15.2 before operation and 11.3 six days afterward. Both were cases of Buerger's disease, and there was very little arterial contraction. We realize that there are many factors concerned and that much work would have to be done before any conclusions can be drawn. The procedure is merely mentioned for the possibilities that it may possess.

2. An elevation of the arterial pressure.

3. An increasing amplitude of oscillations, as shown by the sphygmomanometer.

I have been unable to verify the observation relative to the rise in blood-pressure owing to inability to locate the pulse in the leg. Since we have wanted to estimate this reaction there has been no upper extremity lesion under observation. Leriche believes that the vasodilatation of arterioles and capillaries creates an increased head of pressure and thus causes local hypertension. Variations in skin color and pressure can be understood when we recall the experiments of Krogh. He showed that the capillaries are not merely passively distended by arterial blood-pressure but possess a tone of their own and may show contractions and relaxations independently of the corresponding reactions in the arteries.

The theory upon which Leriche bases the effect of the operation is primarily a disturbed vasomotor innervation with a vasoconstriction responsible for the syndromes. Either by a reflex action or by direct injury the periarterial network is stimulated to constrict the artery. Other factors then come into play. Sympathectomy causes, after the primary stage of constriction, a vasodilatation by breaking the connection and a restoration of vasomotor balance. The possibility of producing dilatation in this way has been questioned by a number of writers. Todd, and also Kramer, studied the nerve supply to the arteries of the upper and lower extremities and found that they received twigs at intervals all the way to the periphery, the intervals growing shorter as the more distal portion of the limbs is reached. They therefore believe that mere sectioning or removal of a segment

of the sympathetic plexus (upon the femoral artery, for instance) cannot affect the sympathetics on the tibial and more distal vessels. Lehman, experimenting on dogs, was unable to confirm Leriche's observation that the secondary dilatation is actually due to the removal of vasoconstrictor fibers. Callender questions the accuracy of Leriche's assumption that the vasoconstrictor fibers mostly lie in the adventitia of the larger arteries, and "that their continuity may be severed, irritated or otherwise interfered with by removal of a thin sheet of tissue about the sheath or adventitia." He also quotes the anatomical studies and opinions of Kramer and of Todd.

There is no doubt, however, that the clinical results are often startling and that the results in certain types of lesion are most gratifying. At the present time, in view of the unsettled state of our knowledge regarding the connection and action of the periarterial sympathetic net, Leriche's observations must be given weight.

The arrangement of the sympathetic system is about as follows: The sympathetic chain receives its impulse from the connector fibers coming from the lateral horn *via* the white ramus communicantes. Excitor fibers start from the ganglia and course to their destination partly along the bloodvessels and partly by passing back to the cord *via* the gray ramus communicantes and thence along spinal nerves to the periphery. Twigs from the somatic nerves, presumably sympathetic fibers, join the periarterial network at frequent intervals. It seems plausible to suppose that a continuous sympathetic impulse, constrictor in nature, flows down the arterial nerve plexus, maintaining vessel tone under normal conditions. Under conditions of stress the distributing stations, *i. e.*, the ganglia, reinforce this impulse along particular fibers, because the excitor fiber coming back through the gray ramus runs straight to its destination.

A lessening of the vasoconstrictor effect will relax the vessels, hence it is clear that the vasodilator nerves are of less importance. They are anatomically indistinguishable from ordinary sensory afferent fibers (Bayliss), and, according to Langley, vascular

dilatation can occur from an impulse traveling "antidromic" on the sensory fibers, *i. e.*, in a direction contrary to what is regarded as the usual one. Furthermore, it seems as though certain metabolic poisons, probably acid in nature—"metabolites" they are called—may produce peripheral dilatation. Finally, there are probably "depressor" fibers in the sciatic and other mixed nerves, and it is known that a depressor reflex will excite the vasodilator center and at the same time inhibit the tonic activity of the vasoconstrictor center.

As you see, the subject is complicated and too little is definitely known to flatly construct a scientific basis for the operation. I have operated on 22 patients, and in 4 a bilateral operation was done. Satisfactory results were obtained in 7 cases, as follows:

1. Two cases of Raynaud's disease were apparently cured, the observations extending for six months and eleven months respectively. Both had bilateral sympathectomy.

3. A case of trophic edema and contractures, with pain in the feet and ankles, was entirely relieved of pain and the trophic state greatly improved. The result was made more emphatic by the fact that the operation was done on one side in September, 1922, and in March, 1923, the patient, a physician, asked that it be done on the other side.

4. A case of cervical rib with trophic and vasomotor syndromes. Sympathectomy was done before the cervical rib was recognized and relief from pain was immediate. Improvement was also noted in a gangrenous patch on the finger and the radial pulse remained absent. Later the rib was removed. Fifteen months later his arm is reported as normal.

5. A case of threatened gangrene of the toe, cyanosis of the foot, perhaps of a Buerger's type, was entirely relieved and remained well fourteen months later.

6. A case of neuralgia, probably trophic, was relieved at once of burning pain and is well six months after operation.

7. A trophic ulcer of six weeks' duration healed in five days.

Partially satisfactory results were obtained in 4 cases:

1. A painful stump, about 75 per cent relieved.

2. A case of causalgia, 50 per cent relieved, perhaps more, but his neurotic state is such that I believe he will relapse.

3. Gangrenous toe with pain, Buerger's type in a Gentile. Partial relief. Cured later by amputation.

4. A painful stump with causalgia. Injection of alcohol into the sciatic gave relief only on posterior aspect. Sympathectomy gave further relief, but I believe he relapsed.

Five cases of typical Buerger's disease in the Russian Jew were operated on in the hope of relieving pain. The rationale depending upon non-involvement of the capillaries by the obliteration and the chance that sympathectomy might cause their dilatation. One was bilateral and 4 unilateral. Three of these were very definitely improved in respect to pain and the others were failures.

I also operated on 3 cases of senile gangrene and 2 of diabetic gangrene. One of each class was improved as regards pain, but amputation was speedily done.

Finally, 1 patient with early senile gangrene and cyanosis developed infection in the wound, hemorrhage followed and ligation of the femoral was done, but she died.

It is evident, therefore, that the operation has a definite place as soon as we have mastered the indications. It is hoped that this relatively simple operation, technically speaking, will give an impetus to the study of the sympathetic nervous system. There are scarcely any data for the study of its morbid anatomy. Recently, Roaf has found degenerative changes in the ganglia in pellagra and suggests that this disease is mainly due to a protein defect acting on the sympathetic nervous system. "The discovery of discharging and destroying lesions would explain symptoms of excessive and defective action respectively." (Bayliss.)

Perversion of the sympathetic response leads not only to toxic goiter, diabetes insipidus, intestinal stasis, etc., but probably also to various trophic and ischemic disorders of the extremities. The study of the etiology of Buerger's disease is far from settled: Is it a toxic endarteritis, or is it a manifestation of a so-called "deficiency disease?" Is it a subconscious reaction against attack with increased adrenin output under the stress of emotion?

DISCUSSION

Dr. John H. Gibbon, Philadelphia:

I have done 5 of these operations. The first 2 were for gangrene of the toe, 1 following amputation and the other an operation on the toe-nail. I have not been able to call these true Buerger's disease. They were both native Americans. These operations were done eighteen months ago and both men have been able to return to and continue their work since operation.

The next was a similar case in which we had a failure. There was relief of pain but an extension of the gangrene.

The last 2 cases were of Buerger's disease. In 1 of these there was a sudden development of gangrene of the foot which necessitated amputation. In the second leg I injured the vessel and was obliged to ligate it. I expected the ligation to be followed by immediate gangrene, as there was no pulse in the foot, but on the contrary, the man's pain was relieved and he developed no gangrene, but his ulcer did not heal.

I think we have been doing this operation in many diseases for which Leriche never suggested it.

I am convinced that there are certain types, particularly trophic cases and obliterative endarteritis, in which the results of this operation are going to be most satisfactory.

There is one point about the operation in which I think there has been some misunderstanding, and that is the removal of the sheath and not the outer coat of the vessel. The removal of the sheath might do some good, but unless the adventitia is removed, of course it is not a Leriche operation.

SPLENECTOMY IN HEMORRHAGIC PURPURA

IDIOPATHIC PURPURA, ESSENTIAL THROMBOPENIE (FRANK). PURPURA HEMORRHAGIC PROTOPATHIQUE (HAYEM)

By JAMES MORLEY HITZROT, M.D.
NEW YORK

The hemorrhagic diatheses have always been of considerable importance to the surgeon because of the bleeding which occurs in these conditions following simple surgical procedures. This interest has recently been stimulated by Kaznelson, who recommended splenectomy upon a patient with essentielle thrombopenie (Frank) in October, 1916, with rather striking results.

Hayem has given a fairly definite set of clinical phenomena as characteristic of essential or idiopathic purpura (purpura hemorrhagique protopathique). The patient has an anemia of the secondary type, with mutliple spontaneous hemorrhages into the skin, from the mucous membranes, etc., recurring at irregular intervals with the following essential features: (1) Absence of any changes in the red blood cells; (2) marked diminution in the number of blood platelets; (3) no constant variation in the white blood cells; (4) normal coagulation time of the blood; (5) a marked increase in the bleeding time; (6) loss of contractility of the blood clot.

Frank, under the term "Die essentielle Thrombopenie," separates this type from the other varieties of purpura and considers it a clinical entity.

Fonio separates the hemorrhagic diatheses (other than hemophilia) into three groups:

1. The Secondary Purpuras. These have a known etiology and include the purpuras which occur in the febrile diseases (small-

pox, typhus, ulcerative endocarditis, etc.), in peritonitis; in blood diseases (the leukemias, pernicious anemia); in diseases of the liver; due to the action of such poisons as phosphorus, benzol, snake venom, etc.; in scurvy, melena neonatorum, etc.

2. The Anaphylactoid Purpuras. The etiology is unknown and the hemorrhagic diathesis is merely a part of the reactive symptom-complex of some anaphylactic agent.

In this group the attacks recur at varying intervals with a free interval in between the attacks. The symptoms are various: Fever, joint pains and swelling, urticaria, erythema, edema, polyneuritis, albuminuria, hemorrhagic nephritis, colic, melena, etc. The occurrence of the various symptoms, the petechial eruptions, ecchymosis, etc., overlap and blend in the different forms and may exhibit their most marked symptoms in varying areas.

The blood platelets are slightly increased or very slightly below normal in number, the clotting time and the bleeding time are normal, and the blood clot contracts normally.

3. Idiopathic Purpura. In this group he places those various forms of the hemorrhagic diatheses which are primary. The etiology is unknown. Without warning bleeding into the skin, from the mucous membranes, melena, hematemesis, nose-bleed and hematuria occur. Fever is absent unless the case is otherwise complicated.

	Anaphylactic purpura.	Idiopathic purpura.
Etiology	Known or suspected causative agent; primary fever; premonitory symptoms	Unknown; no fever; no premonitory symptoms.
Premonitory symptoms	Primary fever, urticaria, edema, joint pains, hemorrhagic nephritis, colic, melena, etc.	None.
Bleeding time . .	Normal	Lengthened.
Clotting time . .	Normal	Normal.
Retraction of clot .	Normal	Absent or markedly diminished.
Blood platelets . .	Increased or slightly decreased	Markedly decreased; may be absent during attack.

	Hemophilia.	Idiopathic purpura.
Etiology	Unknown	Unknown.
History	Classical history of bleeders in family involving males transmitted through female line	No typical history; may have history of similar condition in the family, but no definiteness in the transmission.
Cause of bleeding .	Traumatic	Usually spontaneous, frequently multiple; periodic with free interval; trauma may cause bleeding, but is not so definite as in hemophilia.
Bleeding time . .	Markedly lengthened	Lengthened; (increased especially during attacks).
Clotting time . .	Markedly lengthened	Normal.
Blood platelets . .	Normal or increased in number	Markedly decreased or absent during attacks.

The characteristic features are, increased (lengthened) bleeding time, the absence of retraction of the blood clot or great diminution of this contraction, marked diminution in the number of the blood platelets while the clotting time of the blood is normal.

Fonio gives the schematic forms for the differential diagnosis between anaphylactic purpura and idiopathic purpura, and hemophilia and idiopathic purpura in the above table.

Kaznelson was struck by the observation of Frank, that in the conditions to which Frank had given the name "essentielle thrombopenic" there was a constant enlargement of the spleen, and formulated the hypothesis that the disease was due to some destructive agent which destroyed the blood platelets and that the spleen, because of its enlargement, had some definite relationship to the process of platelet destruction. Acting on this hypothesis in October, 1916, he submitted a female patient, aged thirty-six years, who had had the characteristic features of the essential purpura, described by Hayem, Frank, and others, to splenectomy with remarkable results. The blood platelets which were 300 to 600 before operation rose rapidly to 600,000 on the second day after operation. The clot contracted early and the bleeding time diminished, nosebleed stopped and the menses

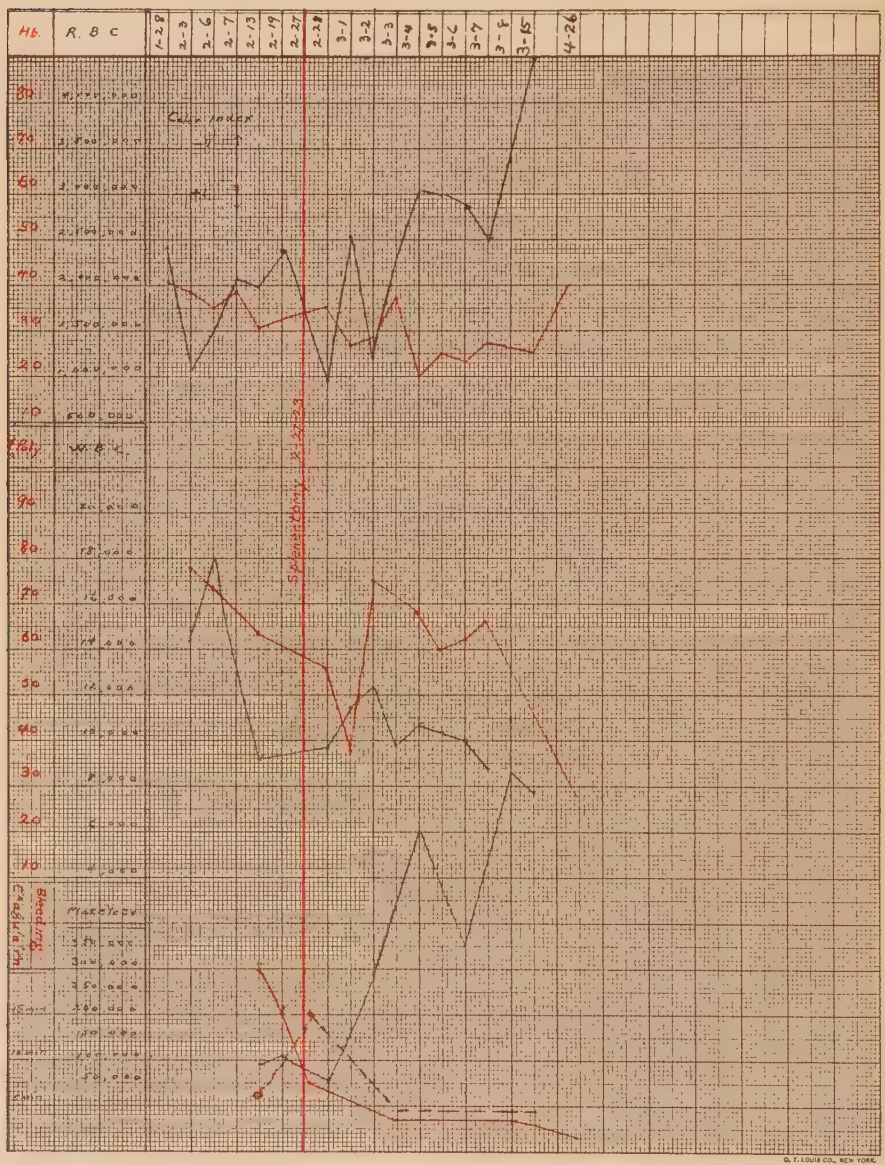

FIG. 1.—Platelets. ———, bleeding time.

became normal in character. He has had the patient under observation for three years and the improvement has been constant.

Since then Kaznelson has reported 2 other cases submitted to splenectomy with a satisfactory outcome. Schmidt, Minkowski, Ehrenberg, Keisman, Beneke, Cori have reported other similar cases in the German literature. In America, Bowen reports a satisfactory case from the Buffalo General Hospital and Brill showed 2 cases at the meeting of the Medical Section of the New York Academy of Medicine on February 15, 1923, submitted to splenectomy with a satisfactory outcome.

Case Report.—Esther C., aged eight years, was admitted to the First Medical Division, Dr. Connor's service, on January 27, 1923, and discharged March 16, 1923.

Her present illness began two days before admission with almost constant bleeding from the nose and gums, and the appearance of red spots on the body. She has not vomited blood or passed blood in urine or stools.

Past History. Patient was well up to three years ago, then had scarlet fever; she recovered and was well up to one year ago. At that time she began to have repeated nosebleeds which were difficult to stop, at intervals of every two or three weeks. One week ago she had a bronchopneumonia from which she is now convalescing. Family history negative for family bleeding; two brothers and sister well.

Examination showed well-nourished, pale child, with hemorrhagic spots on face. Bleeding from left nostril and gums. Heart, lungs, abdomen were negative. Examination of skin showed hemorrhagic areas over the entire body, most marked over the lower extremities. In one area on the hip there was a large ecchymotic area resembling a bruise.

Clinical Pathological Report. Red cells, 2,400,000; hemoglobin, 40 per cent; color index, 0.8; white cells, 38,000; polymorphonuclears, 85 per cent; lymphocytes, 11 per cent; large mononuclears, 4 per cent; platelets, 40,500; coagulation time six minutes; bleeding time more than twenty minutes; clot did not contract.

Fragility Test: Hemolysis began at 0.45; complete at 0.36.

Temperature, 99; pulse, 116; respiration, 26.

Chronological Course. Day of admission: 15 cc whole blood intramuscularly; 15 cc horse serum intramuscularly.

First day after admission: Vomited blood.

Second day: Nosebleed for three hours, packing.

Third day: Nosebleed, slight, packing.

Fourth day: Transfusion 150 cc of blood intravenous (Unger method) followed by chill.

Fifth day: No bleeding since transfusion.

Sixth day: Bleeding from right nostril, packed.

Seventh day: Nosebleed, practically throughout day, partially stopped by packing. 15 cc horse serum intramuscularly.

Eighth day: Enema, large stool containing altered blood.

Ninth day: Nosebleed, hematemesis, transfusion 340 cc blood, followed by chill.

Tenth day: No bleeding.

Eleventh day: Melena, nosebleeds.

Twelfth day: Nosebleed not stopped by packing, cocaine, adrenalin, monochloracetic acid. Stopped with thromboplastin.

Fifteenth day: No bleeding, palpable spleen noted.

Sixteenth and Seventeenth days: Nosebleed slight.

Eighteenth day: Transfusion 250 cc followed by chill.

Nineteenth day: Severe hemorrhage from left nostril for five hours, vomited two pus basins of blood. Nosebleed all afternoon. Not controlled by packing.

Twentieth day: Melena, vomited blood during day. Constant oozing from nostrils not stopped by thromboplastin.

Twenty-first to twenty-ninth day: No bleeding.

Thirtieth day: Profuse nose bleed, chills, much worse. Consultation with Dr. R. G. Stillman.

On February 27, thirty-one days after her admission, at the suggestion of Dr. R. G. Stillman, of the First Medical Division, splenectomy was done through a left rectus incision and a somewhat enlarged spleen easily removed. No hemolymph-nodes were noted along the splenic vein. The liver and gall-bladder seemed normal. The blood was quite watery. Tier closure

of the abdomen without drainage. The wound healed by primary union and the patient was sent to the country on the seventeenth postoperative day.

The essential features of the case following the splenectomy were the immediate cessation of the bleeding, the marked increase in the number of blood platelets from 50,000 to over 600,000, the change in the bleeding time from fifteen to less than five minutes and the marked improvement in the condition of the child. This improvement has continued up to the last observation made on May 25, 1923.

The last observations on the blood made by Dr. Ralph G. Stillman on April 26, 1923 are as follows: Bleeding time, two and one-half minutes; hemoglobin, 40 per cent; polymorphonuclears, 24.0 per cent; lymphocytes, 68.8 per cent; large mononuclears and transitionals, 4.0 per cent; eosinophiles, 2.4 per cent; normoblasts, 1 to each 250 white cells; film shows leukocytosis; well-marked pallor of red blood cells; some granular basophilia and slight polychromatophilia; there are abundant platelets. Looks like a secondary anemia.

Pathological Report. Esther C., May 16, 1923. Hyperplasia of the pulp. Myeloidization. Specimen consists of a spleen of normal contour, rather dark bluish-red color. Capsule elastic, not very tense. Weight with contained blood, 120 grams. (Patient's weight, 47.5 pounds; 21-590 kg.) Size, 4 mm. x 5.5 x 11 mm. On section of capsule much blood escaped, estimated at about 15 cc. Piece removed sterile for culture. Sections placed in formalin, bichloride, Zenker and absolute alcohol. On section the cut surface is smooth, bright red and very thickly studded with follicles that appear of normal size. The consistence is firm, possibly slightly firmer than normal. There was no obvious increase in connective tissue. No hemorrhages were seen. Films made from surface.

Stained film shows the usual number of lymphocytes and large mononuclear cells. Polymorphonuclear leukocytes, neutrophiles are moderate. Eosinophile leukocytes are fairly numerous. There are many normoblasts and a few megaloblasts. There

are also a moderate number of myelocytes, most of them neutrophilic but a few eosinophilic and basophilic. From the cells found in these films one would expect to find in the spleen areas of myeloidization and possibly also of erythropoiesis.

On microscopical examination there appears to be no increase in the amount of fibrous tissue present. Lymphoid follicles all have large germinal centers, but are no larger than one would expect in the spleen in a child of this age. The arteries in the follicles show almost uniformly a thickening and hyalin degeneration of the wall and a narrowing of the lumen. The venous sinuses appear to be approximately normal in size. The pulp in places shows an increased blood content and a hyperplasia of the pulp cords. There are seen in the pulp occasional nucleated red cells and a moderate number of myelocytes. There are also a number of undifferentiated mononuclear cells whose exact nature is unknown. There appears to be a slight increase in the number of eosinophiles present. Collections of blood platelets were not recognized.

Bacteriological Report (Dr. Wheeler). Cultures from the spleen were sterile.

Conclusion. The removal of the spleen has a definite effect in the idiopathic type of hemorrhagic purpura and this effect seems to be related in some way to the change in the bleeding time and in the number of the blood platelets.

Literature

Beneke, E.: Therap. d. Gegenio, December, 1917, p. 418.
Bowen, B. D.: Bull. Buffalo Gen. Hosp., 1923, i, 92.
Cori, G.: Zeitschr. f. klin. Med., xciv, 356.
Ehrenberg, Charlotte: Monatschr. f. Geburtsh. u. Gynäk., 1920, li, 99.
Frank, E.: Berlin. klin. Wchnschr., 1915, lii, 454.
Fonio: Ztschr. f. klin. Med., 1920, lxxxix, 77.
Hayem, G.: Leçons sur les maladies du Sang., 1900, Masson and Cie.
Kaznelson: Wien klin. Wchnschr., 1916, No. 46, p. 1451.
Kaznelson: Zeitschr. f. klin. Med., 1919, lxxxvii, 133.
Keisman: Med. Klin., 1921, No. 3, p. 74.
Minkowski, O.: Med. Klin., 1919, l, 1243.
Schmidt: Berlin. klin. Wchnschr., 1917, p. 959.

DISCUSSION

Dr. C. H. Mayo, Rochester:

I look on the paper of Dr. Hitzrot's as a very important contribution. I would like to add 1 case, the wife of a physician, aged about thirty-eight years, who came here with purpura. She was bleeding at the nose and at the gums, had hematuria, and was also bleeding from the rectum, with most profound bleeding from the uterus. She was packed, with no relief; radium was used locally without any benefit. She had eight transfusions. I finally did a splenectomy with an immediate cessation of the bleeding, and she made a rapid and complete recovery. Every few hours tests were made of the blood, and it was marvellous to see how rapidly the blood platelets increased.

RHINOPLASTY: A PRELIMINARY REPORT

By V. P. BLAIR, M.D.
ST. LOUIS

I WISH to present for the consideration of the Association, as a preliminary report, a résumé of the work we are doing and the conclusions we have so far reached in the repair and reconstruction of the external nose. Possibly one or two of the points may be new, but this is of no weight compared with the fact that many of the procedures have been tried out rather thoroughly and the experience has been sufficiently broad to warrant their use as working principles. I would like to present these conclusions, rather than the often laborious processes by which they were reached, and illustrate each by an appropriate case. I would also like to emphasize the word preliminary, for while we now use these conclusions tentatively as a working basis, still there can be no doubt that technic will change radically and our basic conclusions will be materially modified by increased experience and observation. These conclusions are:

To gain for itself an unassailable place and to be recognized as a legitimate proceeding, corrective surgery of the external nose must produce results that are permanent and are at least comparatively pleasing. In most instances relief is sought for purely cosmetic reasons, though function can often be greatly improved.

This work should not be prostituted to the whims of fancy or to importunities of people whose real lesion is a psychosis.

Happiness and a useful life can at times be just as dramatically restored by the successful correction of a nasal deformity as by

surgical relief of a chronic pain or an intoxication, but the man doing this work who does not carefully weigh the lesion in relation to the mental attitude of the patient is apt to miss the mark just as far and pile up as much trouble as the early oöphorotomist who regarded his pet procedure as a panacea for most of the peculiar ills to which female flesh and spirit are heirs.

That though the cases demanding this work are somewhat rare, it has an economical and sociological bearing relatively as important as any other kind of surgery.

In planning a restoration the breathing space, the lining, the outside covering and the supporting mechanism of the nose must all be considered as well as the general contour of the face.

In most luetic deformities of the nose, and in many noses that appear to recede into the face, the fault is primarily a deficiency of the lining, and where this deficiency is very marked the lining must be supplemented to make the most acceptable repair.

The nose was made for "a blow as well as for show." The first step in the reconstruction may be restoration of the breathing space. In certain cases this is facilitated by the removal of the anterior part of the septum.

Putting a satisfactory patch on a nose may be more difficult or at least require more operative steps than constructing a whole new nose. In a crumpled nose with a damaged mucosa it is usually more expeditious to use the remaining covering skin to make a lining for the breathing space than to attempt to retain it as part of the covering of the new nose. A crumpled ala may advantageously be unfolded to provide lining for the new ala, but it is usually disadvantageous to attempt to use it otherwise. Where part of the original nose is to be retained and the defect filled with a patch, it is absolutely essential for a good result that sufficient scar be removed to allow the remaining natural parts to return to their normal position and shape before inserting the patch.

In the present development of rhinoplasty the sacrifice of a finger for this purpose is justifiable neither by exigency nor the results obtained.

That, as a rule, a pedicled skin flap makes a safer substitute for a mucous lining than a free skin graft; that where a free skin graft is used ample provision should be made for the contraction that will subsequently occur.

That the foreheard flap with its pedicle at the inner end of the brow, the "Indian operation," is the most generally satisfactory and universally applicable of all sources of covering for the new nose; but in special cases the arm flap, "Italian method," may be preferable. The skin from behind the ear (as proposed by Gillies) or the "jump flap," transported by means of the hand, or the forehead flap with a temporal base, may each prove useful.

In making a pattern for a nose flap the width of the flap should be figured very exactly, but an allowance should be made for shrinkage in the length. If in the final result the nose is too long, measured from nasion to tip, it is easily shortened, but the reverse is the more common fault and less easily corrected.

For some time before fixing an "Italian flap," or a "jump flap," to the face the patient should be gradually made accustomed to holding the arm in the unnatural position that will be necessary to bring the flap in contact with the face. Further help can also be obtained by keeping the patient in bed and attaching a cord and counter-weight to the plaster-encased forearm so as to compensate the weight of the cast.

That a supporting mechanism can be built up from the teeth, a dental prosthesis (Martin's method), but that, as a rule, an intrinsic support is better. That live autogenous implants are preferable to foreign bodies, and, of these, costal cartilage for the bridge or aural cartilage for the ala, as recommended by New, are most universally serviceable. That when bone is used to form the bridge it must have actual contact with the nasal or frontal bones, so that true bony union can occur, otherwise it will be absorbed.

That the most satisfactory supporting mechanism for a total restoration is to so cut and suture the flaps, and during the process of healing to so support them, that the nose will sub-

sequently retain the desired shape. If this plan does not give all that is desired then a cartilage implant can be made into the bridge at a later date.

Before attaching the new nose to the face, the face tissues should be fixed by an incision down to the bone along the line of the future nasal attachment. This incision should be made at least two weeks before the new nose is to be attached, and can be conveniently done at the time the flaps are raised in preparation for a delayed transplant. If this is not done the new nose will have no fixed foundation and will tend to spread out over the face.

The delayed transplantation of the flaps is a safer procedure in all rhinoplastics. This is particularly true where the whole nose (lining, covering, and columella) is to be made from one flap or when a flap from behind the ear is to be transferred on a long neck pedicle. There is an arterial block along the anterior border of the sternomastoid muscle that is apt to cause a slough of the distal part of a flap that crosses this line if proper preparation has not been made before cutting the distal attachment.

If the flap be taken vertically from the forehead, and the wound edges be drawn together as much as possible and the remaining defect allowed to granulate, it will give the least possible deformity. If the resulting scar is rough it can later be superficially shaved off and a Thiersch graft applied. This makes the recovery time much longer than when it is immediately grafted. If, however, this "Indian" flap is large and taken horizontally, then it is better to make an immediate full-thickness skin graft to prevent the upward distortion of the brow that will otherwise occur.

In making the final adjustment, do not try to increase the size of the nostril opening by taking out a piece of the lining; it cannot be done that way. Tissue may be taken from between the skin covering, the lining of the ala or from between the two skin-covered walls of the columella; but if any arithmetical treatment is needed on the lining of a blocked nostril it is more

apt to be addition than subtraction. Sometimes a small but very much needed skin flap can be obtained from the lower border of a newly made and overthick ala or columella. The floor of the nostril can be easily widened by a flap taken transversely from the upper part of the lip.

It may be practical to widen the breathing space in the newly constructed nostrils by such operations as thinning the wall, switching skin flaps to the lining and by implanting pieces of aural cartilage or shavings of costal cartilage into the ala; but when the columella is but a strand of tissue it may be more practical to use a U-shaped breathing tube of gold or celluloid. This can be taken out and replaced by the patient. A columella can be made from a vertical or transverse flap taken from the lip. When this is done the raw surface of this flap should be immediately "Thiersch"-grafted. A much more satisfactory plan when the reconstruction includes the external surface or the lining is to provide for making the columella out of the same flap. It is, as a rule, difficult to make a satisfactory columella by displacing the septum and the transplantation of supporting cartilage into the columella is apt to make it objectionably thick.

Saddle-nose consists of a depression of the bridge and usually an uptilting of the tip. To correct the former and neglect the latter may but serve to make the nose grotesque. Therefore the cartilage transplant should be long enough to force the tip down to its proper position, and it is usually safer to attempt to maintain a slight concavity in the bridge rather than risk the possible results of a convexity. Even more unfortunate than cutting the cartilage too short is to allow it to assume too high a position, for this not only fails to correct the elevation of the tip of the nose but also gives undesired prominence to the upper part of the bridge. An excessively long cartilage may produce a too prominent tip; this is easily corrected through a semilunar incision under the nose.

Cartilage should be cut from an accurately made pattern of lead. Where practicable we use the ninth cartilage because it usually requires little trimming, thus retaining perichondrium

on all surfaces, because its removal entails no risk of injury of the pleura and because its loss causes less discomfort than does the removal of a cartilage higher up.

If a cartilage is split longitudinally and one surface retains its perichondrium it will bow with a convexity on the bare surface. This fact may be utilized to advantage, but if overlooked may be the cause of considerable embarrassment to the surgeon. Where it is necessary to split the cartilage and yet desirable to prevent this bowing it may be done by a transverse scoring of the remaining perichondrium. However, should a subsequent infection occur I believe this transverse scoring will lessen the chances of saving the transplant.

There is a special providence that watches over beginners and also cartilage transplants when put into the nose. Within certain limits surgical cleanliness seems not so important as proper drainage of the wound or maintenance of pressure to prevent the formation of a blood-clot or accumulation of serum.

If the dorsal concavity is of moderate degree the costal cartilage can be implanted through an incision made through the skin and saddle cartilage just within one nostril; but if the deformity is very marked with much uptilting of the tip a better result can be obtained by inserting the cartilage through an incision made to correspond to the spectacle bow. These external incisions sound harsh, but on the nose they leave very little scar.

In tunneling for the implantation of a cartilage the upper and lower limits of the undermining should be previously planned and accurately executed; but there is no particular limit to the lateral extent of the undermining, the main point being to go far enough. This undermining should be made just superficial to the periosteum and the saddle cartilage. When the undermining goes beyond the lateral attachment of the nose it is well to place a drain on each side through stab wounds.

When a cartilage is inserted through the spectacle bow incision it tends to slip up and its upper end may tilt forward or to one side. This should be prevented by anchoring with a buried

silk suture. When it is inserted through an incision made within the nose it tends to assume an oblique position, with its lower end pointing toward the incised nostril and the upper end toward the opposite eye. This is to be controlled by properly placed sutures that engage the superficial and deep layers of tissue, and which are tied externally over bits of tinfoil or gauze. If tied too tight or left in place too long they will cause ulceration of the skin. The tinfoil or lead is safer than the gauze. These sutures do not penetrate the cartilage.

The operator should make the proposed reconstruction in clay on a plaster cast and cut all patterns and make lasting marks and outlines on the face of the patient before doing any cutting on the patient's tissue. Though he may and probably will fall short of his ideal, his results will in this way average very much better than if he approach the operation haphazard.

ACTINOMYCOSIS*

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My attention has been directed to this subject by a recent case which, going on to a fatal ending, allowed of a postmortem which revealed the origin of the disease about the appendix. It is the latest of a series of 4 cases which I have had, and in reporting these, I desire particularly to present this case of actinomycosis of the appendix.

The ray fungus which causes actinomycosis originates in the rust sometimes found on grain and grasses. It is common among cattle, producing lump-jaw, and occasionally it is found in man, most frequently in the cervicofacial region, and less often in the region of the appendix. Rarely it is found in the lung or liver, and a few cases are on record where it attacked the central nervous system.

The condition under which the ray fungus—the actinomyces bovis—attacks man are not quite clear, for a study of all recorded cases gives one the impression that while in America it occurs most frequently in those localities where the disease is most prevalent in cattle, in England it bears no such relation, and the disease is by no means confined to millers and farmers, as the text-books would lead one to believe, but is seen among all classes. Men are affected much oftener than women, and the age incidence is between twenty-four and forty-five years.

The routes of infection are from carious teeth or the throat to the cervicofacial region, as shown by the researches of Lord,[1] and from the lumen of the intestine in the abdominal variety

* Read by title.

as pointed out by Wright.[2] Case I, here reported, which seems to show the appendiceal origin, tends to confirm the early views of Ransom[3] and later those of Battle and Corner[4] and Cope.[5] The spread of the disease occurs by continuity of tissue and never by the lymphatics. The abdominal variety frequently shows spread to the liver in the form of a portal pyemia.

The disease is seldom recognized in the early stages, it being mistaken for one of the commoner diseases which it so closely resembles, until, in the majority of cases, it has a firm foothold in the tissues. The diagnosis is rendered difficult by the insidious onset and the essential chronicity of the lesions, but there are definite symptoms in each type of the disease which, when borne in mind, help toward avoiding the too common error of thinking it a case of tuberculous glands, Hodgkin's disease, sarcoma or appendicitis.

The cervicofacial type occurs in about 8 out of 10 cases, and while the swelling itself may not present any early distinctive features, the persistence of trismus independent of the size of the lump or any nerve involvement is pathognomonic. Later when the swelling, which is smooth, hard and painless, without any definite boundary, becomes hyperemic, softens in places, breaks down discharging a little thick pus, heals and becomes puckered, and presents alongside the puckered areas newformed eminences going on to pus formation, the picture is unmistakable, and thorough and repeated search should be made by the surgeon or his assistant for the organism in the pus. A sinus may be found extending out from a neighboring carious tooth, as in Case II. The pus contains minute sulphur-like granules in which the ray fungus is seen when examined under the microscope. When these are found the diagnosis is no longer questionable and active treatment is instituted.

In the abdominal type the diagnosis is not so easy and one is very prone to mistake the condition for subacute or occasionally acute appendicitis. The mistake is not in considering the case one of appendicitis, for inflammation and actinomycotic involvement of the appendix is actually present, but in over-

looking the nature of the infection which spreads to involve the retroperitoneal tissues, giving symptoms which identify the disease. The woody hardness of the tissues invaded by the Actinomyces bovis accounts for one symptom which stands out as characteristic. It is the flexion of the right leg at the hip, due to involvement of the psoas muscle, and pain on attempting to extend the thigh. When this symptom is present and is accompanied by those which point to inflammation of the appendix or cecum, and there are the physical findings of a painless hard tumor in the right iliac fossa, which has developed too rapidly to be a cancer and too slowly to be an appendiceal abscess, no involvement of the peritoneal cavity and only a moderate degree of constitutional symptoms, one should suspect actinomycosis. The absence of any lesion of the spine and the fluctuation found in a psoas abscess rules out Pott's disease. Brockman[6] groups the symptoms into four stages: (1) Varying abdominal symptoms mainly confined to the right iliac fossa; (2) the presence of a tumor in that location; (3) sinus and fistula formation; and (4) repair or dissolution. In the later stages of the abdominal types, when sinuses have formed, the diagnosis may be made by isolating the sulphur granules from the discharge.

Occasionally the disease may spread by continuity of tissue to involve the scrotum while remaining more or less hidden within the abdomen. Such cases are extremely misleading. Case I was of this type.

The prognosis depends upon the location and duration of the disease. In the cervicofacial lesion an early diagnosis gives good hope for a complete recovery while in the abdominal type the mortality rate is 80 per cent.

Treatment resolves itself into local and general. The local treatment differs with the location of the disease. In the cervicofacial type total excision is desirable and usually possible. Along with excision, cauterization of the tissue should be employed. The *x*-ray and radium have been used in the early stages of the cervicofacial type with varying success. In the

abdominal type simple incision with drainage gives the best results. Curetting should not be undertaken.

Constitutionally the best success results from repeated large doses of potassium iodide. As much as 100 gr., three times daily, may be given. Case II took 320 gr. daily for nearly a month. Along with this autogenous vaccines of both the actinomyces and any accompanying infection may be used. The vaccines have not proved of much value in the treatment. Bevan[7] advocates the administration of copper sulphate, $\frac{1}{4}$ to 1 gr., three times daily along with the potassium iodide, and local irrigation of sinuses with a copper sulphate solution, 1 per cent. This treatment has also been used at the Mayo Clinic.[8]

Fresh air, sunshine and moderate exercise when possible are very important in the constitutional treatment.

Case I.—P. L., male, aged sixty-one years. Had been in the railway service practically all his life. The present trouble began with acute abdominal cramps and diarrhea. A few days later a swelling appeared in the right side of the scrotum and a diagnosis of strangulated right inguinal hernia was made. The scrotum was opened by his local physician and a quantity of very foul-smelling pus (with a fecal odor) was evacuated. In spite of this his temperature remained high and he became delirious.

When first seen by me October 1, 1922, the right side of the scrotum was greatly swollen and the testicle had herniated through an opening in the skin. The opening was enlarged and the finger passed up to the external abdominal ring and freer drainage provided. On examining the abdomen there was no rigidity or tenderness in the right iliac fossa. There was considerable immediate improvement following freer drainage, but in a few weeks' time he commenced to go downhill again, and on November 30, slight fulness having been noticed in the right iliac fossa with flexion of the right thigh, Beck's paste was injected into the sinus and an *x*-ray made which showed the sinus communicating with the iliac fossa.

FIG. 1.—Appendix and wall of abscess. 1, wall of abscess; 2, appendix communicating with abscess cavity; 3, cecum; 4, terminal portion of ileum.

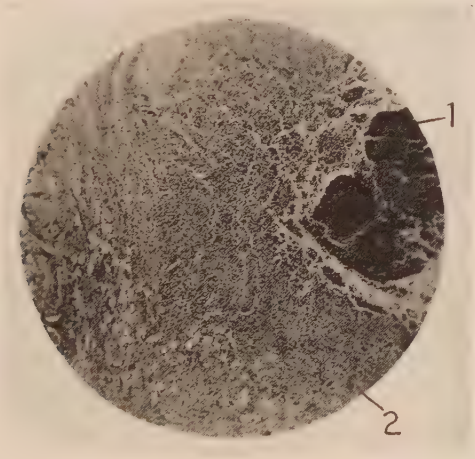

FIG. 2.—Low-power view of wall of abscess cavity, showing colonies of ray fungus. 1, colonies of actinomycosis; 2, inflammatory reaction.

I then opened extraperitoneally an abscess cavity lying on the venter of the ileum, lined with granulation tissue, necrotic

FIG. 3.—Liver, showing actinomycotic abscess formation.

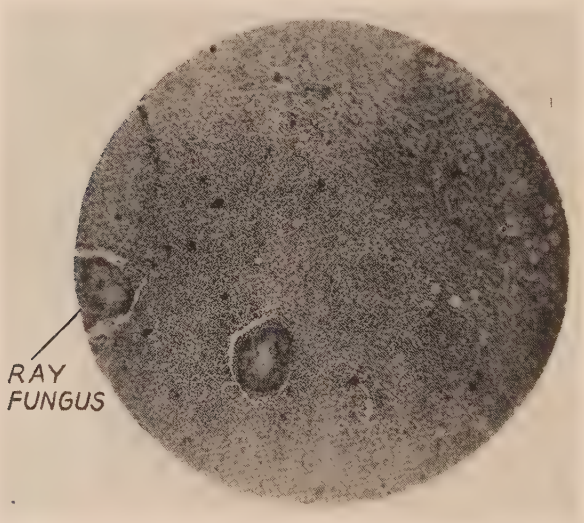

FIG. 4.—Section from liver, showing ray fungus with abscess formation.

muscle and bone. It extended mesially to the transverse processes of the vertebræ and upward along the psoas muscle. The situation, the destruction of the psoas muscle and ileum suggested tuberculosis rather than a lesion of appendiceal origin. However the tissue removed showed actinomyces, and filaments were also found in a Rosenow blood culture. Consequently potassium iodide was given orally and *x*-ray treatment com-

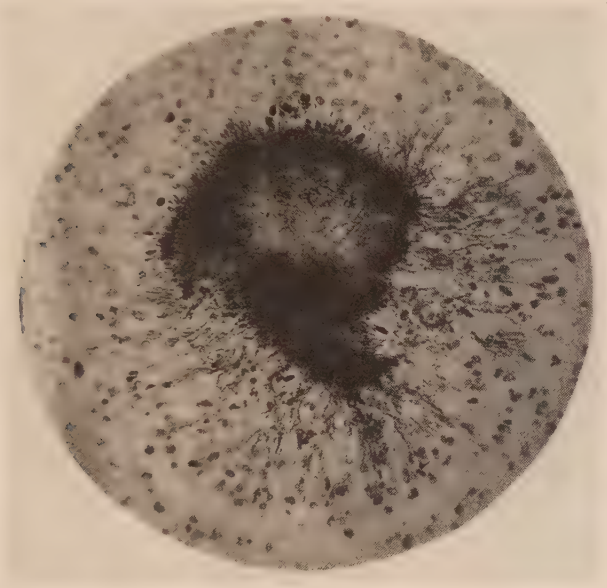

FIG. 5.—High-power view of the ray fungus, showing filaments and clubs.

menced. In view of Osborne's findings no iodide was given intravenously, as it was felt that a more constant concentration in the blood could be maintained by oral administration in divided doses.

The drainage persisted, being of a reddish, muddy type, about 1 to 2 drachms daily. The temperature ranged from 99° to 101.° There was a constant leukocytosis (December 20, 12,000; 78 per cent polymorphonuclears; February 2, 22,660;

89 per cent polymorphonuclears). During the last month he suffered greatly and he became almost childish mentally, with progressive loss of strength and flesh, until he died on March 1, after an illness of five months.

Postmortem examination performed by Dr. G. W. Loughead disclosed the origin of the trouble about the appendix. In this region there was a large mass with numerous adhesions. In the base of this mass was situated the appendix, which was attached to the muscles and the peritoneum of the crest of the ileum. Surrounding this was a collection of dark greenish pus. The external wound connected with this, so that there should have been good drainage.

The liver was very much enlarged, extending to the umbilicus. Left pleural cavity contained about 200 cc of dark greenish purulent material. Right pleural cavity showed some recent pleuritis. Pericardial cavity contained 20 cc of straw-colored fluid. In the left lung, near the anterior portion of the lower lobe of the lung, is an abscess cavity which had perforated into the pleura. The lung on section showed areas of consolidation and small abscess formation scattered throughout the lower lobe. In the right lung small abscesses the size of a pea are scattered irregularly throughout the whole of the lung tissue. The liver markedly increased in size; weight about 2800 gm.; surface smooth; has a dull gray appearance and cuts with resistance; leaves grease on the knife. Scattered throughout the liver are numerous small nodular masses which are beginning abscess formations. The central veins are slightly congested. The left kidney was larger than normal; capsule strips readily; cortex rolls out; has a grayish appearance; the pyramids are slightly congested; pelvis contains a slight increase in peripelvic fat. Scattered throughout the kidney substance are small abscesses the size of a pin's head. The right kidney was similar to the left. The pancreas was apparently normal. The suprarenals show slight congestion. The appendix is about 3 inches in length; the lower end is thickened and is attached to the brim of the pelvis and situated in a pocket of pus. The peritoneum

around this area shows small yellowish areas of pus, probably spreading from the tip of the appendix. The spleen is increased in size. On section its surface has a dull red appearance. Some pulp on scraping; tubercles are not prominent. There is some evidence of perisplenitis present.

Microscopical Examination. Section from the abscess cavity around the tip of the appendix shows tissue infiltrated with polymorphonuclears, lymphocytes and plasma cells and gathered together in granulomatous areas, in the center of which is situated a ray fungus. This fungus shows distinct rays with some clubs present. The liver shows irregular infiltration with these granulomatous areas, and numerous ray fungi are present. The spleen shows infiltration of polymorphonuclears and deep congestion. The kidneys show an occasional colony of actinomyces similar to the liver. The pancreas is apparently normal. The suprarenals are apparently normal. The bowel shows slight congestion. The heart muscle shows congestion and slight inflammatory infiltration around the bloodvessels. No colonies found. Ray fungus scattered throughout the lungs; rather irregular small abscesses, the center of which show ray fungus. The left lung near the anterior free margin shows a perforation into the left pleural cavity with necrosis of the lung tissue. The left testicle is apparently normal and shows slight congestion.

Case II.—Cervical. L. B., male, aged thirty-nine years. He had a swelling in the right submaxillary region associated with a tender lower first molar tooth, from which pus was discharging through a sinus into the mouth. On extraction of the tooth, examination of the pus revealed the ray fungus. Under large doses of potassium iodide the swelling in his neck diminished slightly, but a hard mass remained and was removed by operation.

Section of this showed the typical appearance of actinomycosis. He continued on treatment with iodide of potassium for a period of six months, at one time taking 320 gr. a day for

about three weeks. At the end of six months he was apparently entirely free of the disease and treatment was discontinued. Five years have now elapsed without further manifestation of the disease. He is in splendid health, and I think we may consider that a cure has been effected.

Case III.—A male, aged forty years, a town-dweller, was sent into my service with a mass in the right iliac region which developed slowly and had an indurated, solid feeling to it, very closely simulating carcinoma of the cecum. On making an incision some pus was evacuated and drainage instituted, the pus showing the actinomyces fungus. He was some months in the hospital under iodide treatment and left slightly improved. I am not able, however, to give the ultimate result.

Case IV.—Male, aged forty-five years, with actinomycosis of the left lung. Drainage instituted.

References

1. Lord: Jour. Am. Med. Assn., 1910, iv.
2. Wright: Jour. Med. Research, 1904–5, xiii.
3. Ransom: Med. Chir. Trans., 1892.
4. Battle and Corner: Diseases of the Appendix Vermiformis, 1904, p. 164.
5. Cope: British Jour. Surg., 1915, iii, 53.
6. Brockman: British Jour. Surg., 1923, No. 40, x.
7. Bevan: Jour. Am. Med. Assn., November 11, 1905.
8. Brogden: Jour. Lab. and Clin. Med., 1922, No. 3, viii.

A QUESTION OF SIZE

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When Brown, the English botanist, began the observations on physics which culminated in his written communications of 1827, he focused attention on a subject of enormous importance. The questions he raised a century ago are today perhaps the most important of all those before the scientific world. Brown noted, as man undoubtedly had noted from time immemorial, that when a pencil of bright light was thrown into a dark room there were to be seen in the air certain rapidly moving particles of which there was no other physical evidence. On experimentation he found these dancing motes under conditions in which freedom from air disturbance of any kind had been obtained, and he further noted with the microscope the continual movement among minute particles suspended in a liquid. Because of his investigations the peculiar vibratory motions of these particles were called Brownian movements. The great physicist Dalton was at this period working on the atomic theory and the constitution of the molecule, and in connection with his investigations the so-called Brownian movements were even more happily designated "the dance of the molecules." The most important contribution to a proper understanding of these phenomena was that of Thomas Graham, Master of the Mint in London, who in 1861, published his painstaking observations which led to the first great description of colloid bodies. Graham's work was largely based on dialyses of colloid-sized substances through parchment paper. Tyndall called attention

to the curious phenomenon occurring in the track of a luminous beam (called the Tyndall phenomenon) the colorings of which are the effect of sunlight on colloids in the air, and investigated the transparency and opacity of gases and vapors under radiant heat.

To those who have given little thought to the term *colloid*, especially as it is used in medicine, the word appears to have some special meaning over and beyond that of size, but, as a matter of fact, colloid refers only to size. Dividing matter into three great groups, there are: First, those objects which can be seen directly with the eye or with the eye aided by the microscope. The best microscope has a magnification which will reveal objects of $\frac{1}{10}$ micron in diameter. Second, at the other extreme there are the atom, the molecule and the electron, which cannot be seen. Third, those particles of matter lying between the two extremes in size ($\frac{1}{10}$ of a micron or $\frac{1}{250000}$ of an inch and $\frac{1}{1000}$ of a micron or $\frac{1}{25000000}$ of an inch) are called colloids. In this third or colloid group the particles are too small to be seen directly, but the colloid-sized particles are large enough to scatter a ray of light, and they therefore refract the light ray. The atom, the molecule and the electron are too small to scatter the light ray and therefore do not refract it, although under experimental *x*-ray conditions the nucleus of the atom was demonstrated by Thompson and Ashton. Definite relationships can be shown, as evidenced in 1913, by the remarkable work of Henry Moseley, a young Englishman, whose death in the Gallipoli campaign was one of the irreparable losses of the Great War. Moseley analyzed the atom by the reflection of *x*-rays and showed that there were 92 possible elements between hydrogen, the lightest, and uranium, the heaviest, all but 4 of which are now known.

The ultramicroscope which is used to catch the reflection of the colloid bodies gives no idea of the shape or the composition of the object itself, but by serving as a mirror and reflecting the light shows that such a body is actually present. The shortest ray of electromagnetic vibration is the gamma ray from radium,

$\frac{1}{10000000}$ of an inch. The next is the *x*-ray, which is about $\frac{1}{100000000}$ of an inch. It was with this extremely short *x*-ray that Moseley did his work. The wave length of the *x*-ray, which in this connection amounts to the same thing as size, is $\frac{1}{50000}$ as great as the yellow light ray from the sun, and it is to this property that the *x*-ray owes its great penetrating power. The shortest light ray visible to the eye is approximately $\frac{1}{30000}$ of an inch in length. The longest waves are the Hertzian, so-called wireless, which are from one-half mile to four or five miles in length, and experimentally have reached the length of 1200 miles or more.

A most remarkable fact is that colloids, atoms, molecules and electrons are not greatly affected by gravity and remain in rapid motion, more or less permanently suspended in their medium, although all are affected by pressure, temperature and atmospheric conditions. The evaporation of water is an illustration of this property. Water exists in the atmosphere, but under certain conditions does not greatly feel the pull of gravity. Under specific atmospheric conditions, however, as when the evaporated water rises to a height where the air is rarefied and by greater coldness than exists at the point of evaporation, it gathers together in colloid form as clouds. For rainfall of an inch and a half to an acre, 144 tons of colloid water practically unresponsive to the pull of gravity are suspended over each acre; if the change from a dispersed to a fluid state takes place rapidly the electrical energy on the surface of the colloidal particles is given off as an electrical disturbance—thunder and lightning.

Gortner and his pupils may influence the feeding of the world by their discoveries of the importance to plants, of water in a bound form, and their demonstration that the effect of freezing and dryness on plant life depends on whether the water contained by the plant existed in a free form or a bound form. The difficulties which stood in the way of finding food plants which would withstand winter killing were enormous. Years of patient waiting were often necessary before weather conditions existed

to make the demonstrations possible. When Gortner conceived the idea that water might exist in a bound state uninfluenced by ordinary conditions, atmospheric or thermic, he found that if plants which did not winter-kill were pressed in a hydraulic press, little or no juice was obtained, and that the amount of juice that could be expressed was directly related to the ability of the plant to withstand frost. He found that those plants which would not winter-kill contained little unbound water, that is, water in a free form, while those that were destroyed by freezing contained relatively a large amount of free water. Carrying his experiments out in the desert, he found conditions comparable as to drought; plants that could withstand dryness contained water, as did other plants, but in a bound form. Experiments in the compression of water, which is one of the most incompressible of all substances, have shown that the water in a film on colloid surfaces can be compressed to 75 per cent of its volume, and that under such conditions it behaves as a solid and does not evaporate at 300° C. in a complete vacuum.

We know that a substance in solution, common salt for instance, exists, although it can no longer be seen; when the water is evaporated the salt is again in evidence. If a pencil of light is thrown through such a solution it will not be diffused, showing that the light rays have not met bodies in the solution which are larger than the ray of light, and consequently the light is not reflected. It was Arrhenius, the Swedish scientist, who defined the electrolytic theory of solution, asserting that salts separate in water into positive and negative parts, and that such solutions are ionic. An ion is an unsatisfied electrical charge. A chemical reaction is always accompanied by an exchange of electrical charges between elements; the ion carries a definite charge and moves with the electrical current. Colloids, atoms and molecules may give off electrical energy under certain conditions.

One may well ask, Where does the energy contained in the atom, molecule and colloid reside? The Nobel Prize in Physics for 1922 was given to Dr. Niels Bohr, of Copenhagen, who about

ten years ago revealed his conception of the atomic system as a solar system in which the sun is represented by a nucleus of positive electricity and the planets by rapidly revolving negative electrons, and on this theory he calculated the wave length of light in each line of the spectrum. The positive core of the atom is exceedingly dense and heavy compared with the electron, in which the activity of negative electricity resides. The positive core might be said to be the electrical center of gravity toward which the negative electrons constantly are pulled. Knowledge of electrical energy is largely based on an understanding of the negative electron which is only $\frac{1}{1800}$ the density or weight of the positive hydrogen nucleus which is the smallest and lightest of known atoms of matter. It is because of its extremely small size and weight that the negative electron can move with such extraordinary rapidity through solid substances, especially copper and other electrical conductors.

The force that exists in the atom and molecule is inconceivable. Rutherford, the great physicist, says that he looks forward to the day in which energy for all our uses will be atomic. One of the scientists associated with the General Electric Company says there is sufficient energy in a teaspoonful of water to drive the largest battleship across the ocean. The electric power in the molecule depends on the mass of the nucleus, that is the number of positive charges in the mass, and the number of negative electrons circulating around the positive nucleus, the charges in the more stable compounds going up in arithmetical progression of four, the octet being the most stable.

Most of the biochemical reactions in the body depend on physical states. Krogh, whose experimental studies of the blood capillaries won for him the Nobel Prize in Physiology in 1920, has added greatly to our knowledge of the mechanism of body nutrition. It had been believed that the capillaries were endothelial channels in the tissues, but Krogh has confirmed the observation that even the finest capillaries contain smooth muscle fibers, through the walls of which oxygen and crystalloids, such as glucose, salts and the amino-acids, supply the body cells by

diffusion. Diffusion depends on pressure. Crystalloids are in a molecular state and penetrate the capillary walls everywhere, because the pressure inside the arterial capillary is greater than that in the tissue space, and greater in the tissue spaces than in the venous capillary which received the waste products of oxidation. Unless there is great dilatation of the capillaries, which increases their permeability to larger bodies, the colloids normally do not penetrate the capillary walls, except in the liver and gastro-intestinal tract. Histamin dilates the capillary wall so that its interspaces permit the escape of larger-sized particles, such as colloids, and as in shock the experimental animal bleeds to death in its own tissues. The colloids of the blood are of different sizes; hence, there is variation in the permeability of the capillary wall to different colloids. The osmotic pressure, the state of dilatation of capillaries and the size of the colloid molecule are the controlling factors. Increased work of any organ of the body causes dilatation of the capillaries. This power of dilatation and contraction lies in the nonstriated muscle coat of the capillary. Variations in caliber of the capillaries may be brought about by the many influences which affect life processes and are to a great extent independent of nerve control. For instance, the effect of cold on the skin is to produce contraction of the arterial capillaries, resulting in blanching, which is followed by blueness due to dilatation and stasis of the venous capillaries distended with non-oxygenated blood. One can conceive that many substances, said to be poisonous, are poisonous because of their physical condition; certain tissue filters may become plugged by particles which of themselves are not poisonous in the chemical sense but are attracted to certain localities and plug the normal interspaces, suspending internal respiration.

The point should be emphasized that normally the blood capillaries pick up only molecular substances or extremely fine subdivisions, soluble in water. Generally speaking, it is the function of the lymphatics as absorbents to pick up material substances insoluble in water, such as bacteria, protozoa and

the cancer cell, which are too large to enter the blood capillaries. This absorption is through the agency of phagocytes, which by diapedesis reach the lymphatics. The reactions in the lymph nodes represent the struggle of the gland to detoxicate these pathological agents. The lymphatic channels lead from one gland to another, but in each gland they break up into lymphatic capillaries, varying from 1 micron to 1 mm., and into endothelium-lined pockets and sinusoids before they are gathered again into the larger lymphatic channels for onward movement. These physical facts are of the greatest importance in relation to the infections which spread by way of the lymphatic system, such as tuberculosis, syphilis and cancer.

Bacteria are electronegative, but the bacterial spore carries a positive charge. Evidence goes to show that endothelial cells which are phagocytes are electropositive. This research is incomplete, however, as an entire series of cells has not been worked out.

An idea of the minuteness of the constituents of a cell is gained from the following estimated analysis: A cell is composed of (1) protein, which is always colloid; (2) carbohydrates, which may be either crystalloid or colloid; (3) lipoids or fats, which are either colloids or emulsions; (4) salts, which are crystalloid; (5) water, some part of which, large or small, depending on the physiological state of the cell, may be in colloidal form. As a specific instance the composition of a liver cell, expressed in molecules, is estimated to be: Protein, 53,000,000,000, fats and lipoids 166,000,000,000, salts and other crystalloids 2,900,000,000,000, and water 225,000,000,000,000.

Perkin, working in the Royal College of London, discovered the dyes which Hofmann took back to Germany and which were the basic discoveries that gave rise to the explosives exploited in the World War. Abel and Rowntree, in 1909, and Rowntree and Geraghty, in 1910, in working on the elimination of aniline dyes from the kidney, were led to the discovery of phenolsulphonephthalein as an index to renal function. Evans has shown that dye elimination is purely a question of physics, that is of the

size of the dye particle which is permitted to pass the kidney filter. Bowman, for whom Bowman's capsule was named in 1842, made the first of that long line of studies on the Malpighian bodies in relation to the system of tubules of the kidney, work continued later by Ludwig, Cushny, Marshall, Richards, Drinker and others, which suggested that the essential action of the kidney was that of a filter. Sollman, seventeen years ago, in his perfusion experiments, found that the kidney of an animal removed from the body could be made to filter urine. Cushny, by his pharmacological investigations of the elimination of drugs from the kidney, developed most important data as to kidney filtration. While it is true that urea is excreted in small amounts in the saliva, through the skin, the mucous membranes of the intestine, and so forth, the natural urea filter is the kidney. In this connection it is most interesting to note that urea is one of the smallest of the colloid molecules, being but slightly above atomic size, and that it is non-hydrophilic, that is, it does not absorb water. For this reason it is one of the most diffusible colloid molecules and passes with great rapidity in and out of the tissues of the body. While urea is non-hydrophilic, its elimination through the kidney is closely associated with the water balance. Reduced urea output is accompanied by a corresponding increase of the watery constituents of the urine if a fair degree of renal function is maintained.

Sir William Crookes, who died in 1919, was the last of the great all-around physicists. Physics has grown so tremendously that each physicist of today can claim to have accurate knowledge of only a small part of the subject. Crookes, in his attempts to demonstrate the fourth state of matter, exhausted the air from a heavy glass bulb. When certain electrical attachments were made the bulb became filled with luminous matter, and, as Crookes expressed it, "actually touched the border-land where matter and force seem to merge into one another." He named this luminous substance the cathode ray, which was later shown to be composed of negative electrons, which is the fundamental conception of the *x*-ray. He pointed out also that when *x*-rays

come in contact with solid matter they give rise to shadows, and that the cathode rays, when outside a magnetic field, always travel in a straight line. Roentgen was working with the Crookes tubes when he discovered the *x*-rays. The use of energy in the form of rays such as radium, *x*-ray and so forth is an example of biophysics in relation to medicine. Bayliss, speaking of chemistry and physics, says that "The boundaries between these two branches of science are rapidly becoming obliterated."

When we survey the modern field of research which goes under the general title of biophysics, the commercial inventions and developments that concern physics in the sciences and arts, we get some idea of the importance of this work which has been neglected in its relation to medicine. Problems worked out in connection with industry, agriculture and animal husbandry have raised scarcely a ripple in medicine. Perhaps we have been subject unconsciously to the theological opinions which have recently been so broadly emphasized by a world-known orator who believes that man was created independently and not through evolution of preëxisting species, a view more flattering to our vanity than to our intelligence. One cannot help, however, but sympathize with his recent vehement defense of the ape as not responsible for man.

Perhaps enough has been said to further the plea that biophysics be given a more important place in the medical school curriculum, and that some of the time of the overburdened students of medicine now occupied by chemistry be given to medical biophysics.

DISCUSSION

Dr. George W. Crile, Cleveland:

I wish to say a word as to size: Hugo Fricke, Ph.D., the biophysicist of our clinic, has found that the exact thickness of the membrane surrounding the cells is of the order of $\frac{1}{10,000,000}$ cm., that is to say, the thickness of the membrane around the cells is equivalent in its diameter to 1 molecule of oil. Thus the films which surround the cells are equivalent to films of oil.

CARCINOMA OF THE BLADDER

By JOHN B. DEAVER, M.D.

AND

WILLIAM H. MacKINNEY, M.D.

PHILADELPHIA

(By Invitation.)

This contribution to the study of carcinoma of the bladder is based upon the analysis of 131 cases occurring in our experience since 1910.

Of these 131 cases, 107 (81 per cent) occurred in the male and 24 (19 per cent) in the female, a ratio of approximately 4 males to 1 female.

An analysis of the age at which these cases occurred may be gleaned from the appended chart, showing that while carcinoma occurs at practically every age in adult life, it is most common in the fourth, fifth and sixth decades, during which periods 100 of our cases have occurred. The average age in the total number of cases was 54.2 years. The statement has been made that carcinoma of the bladder is more commonly met with at an earlier age than carcinoma of other portions of the body. In our cases, however, the average age is about the same as carcinoma situated elsewhere.

Interrogation of the patients led to the discovery of a family history of carcinoma in 16 (12.2 per cent) of the patients. Two patients with carcinoma of the bladder had previously been operated for carcinoma of the breast, and in 1 case the wife was operated upon for carcinoma of the uterus.

Six of the 131 cases had been operated upon for tumor of the bladder prior to coming under our observation. These cases are of special interest because of the long interval between

operation and the date of recurrence. One case was operated upon twenty-one years before recurrence, 1 case nine years, 1 case six years, 1 case five years, and 2 cases four years, thus proving that no time limit of cure can be estimated in dealing with carcinoma of the bladder.

The diagnosis of carcinoma of the bladder was based upon: (1) The microscopical examination of specimens removed by operation; (2) the microscopical examination of pieces of tumor removed by forceps or passed by the patient; (3) cystoscopical examination. Microscopically, the evidences of malignancy vary within wide ranges—from the early degeneration of the epithelial covering of what might cystoscopically be judged benign papilloma to the advanced carcinomatous papilloma, and finally the infiltrating squamous-cell carcinoma. This last type constitutes the most malignant carcinoma of the bladder excepting the adenocarcinoma, which has not been encountered among these cases examined microscopically. Correlating the clinical and microscopical findings, we have come to the conclusion that a truly benign tumor of the bladder is rarely encountered and that tumors of medium or large size invariably show microscopical evidence of malignancy.

A review of the symptomatology of bladder tumor adds nothing of interest except to emphasize the lamented fact, recognized by every surgeon and urologist, that hematuria, the cardinal symptom of tumor, is disregarded as a symptom of serious import by the physician and that procrastination takes the place of the cystoscope.

In only 21 cases was a cystoscopical examination made before three months of hematuria, and in 35 a period of from three months to one year had elapsed. In 48 cases a history of bleeding for over one year was elicited, and in 26 of these a history of hematuria for more than two years. It is indeed surprising how long a tumor of the bladder may exist and give rise to periodical bleeding, and yet for many years have no apparent effect upon the general health of the patient. This would indicate that a large percentage of vesical neoplasms

show a low degree of malignancy, and this, coupled with the fact that these tumors do not show a tendency to early metastasis, should place carcinoma of the bladder in a particularly favorable field for early curative surgery.

Pain is not a pronounced symptom of tumor, and when it occurs it is usually late in the disease. Symptoms of cystitis—frequent, urgent urination, with pus and blood in the urine—are a frequent complication of carcinoma, in contrast with benign tumors which are rarely so complicated.

From a cystoscopical standpoint it is usually not difficult to make a diagnosis of tumor of the bladder, since few pathological conditions simulate it. Syphilis of the bladder gives rise to a nodular infiltration of the wall of the bladder, which may ulcerate and simulate carcinoma. It is impossible to differentiate the condition and a positive Wassermann test should be followed by an active therapeutic test before surgery is advised. Some types of ulcerative cystitis, particularly a variety occurring in diabetes, of which we have seen two examples, resemble in appearance an ulcerative carcinoma. Fortunately, routine urine examination detects the presence of sugar and under proper diabetic régime the cystitis subsides. Tuberculosis of the bladder rarely simulates tumor, particularly when manifested in the form of a tuberculoma.

While the diagnosis of neoplasm is usually easy, it is not always possible to differentiate the truly benign tumor from the early malignant one. Microscopical examination of pieces of apparently benign tumors show epithelial changes of various degrees, all indicative of malignancy, and these changes have so frequently been reported in cases of cystoscopically benign tumors that we are led to believe that a truly benign tumor of the bladder is a rare occurrence. This is, furthermore, borne out from a clinical standpoint by the frequency of recurrences under any form of treatment, and by the fact that microscopical examination of these recurrent tumors may show malignant changes undiscovered by the microscopical examination of the primary tumor.

Cystoscopically, the characteristics of papillary carcinoma of the bladder are shortening or absence of the villous projection, evident ulceration of the tumor surface, an impression of density and an infiltration of the site of attachment with a broad, sessile base. In more advanced papillary carcinoma the bladder wall at the site of the tumor is infiltrated and edematous, while the remaining bladder mucosa is inflamed. Cystitis rarely accompanies a benign growth, so that the presence of a cystitis complicating a tumor is evidence of malignancy. Multiplicity of tumors is usually but not always indicative of malignancy and likewise large tumors are practically always microscopically malignant. The cystoscopical diagnosis of infiltrating carcinoma of the squamous-cell type is based upon the presence of a tumor involving variable extents of the bladder wall, rarely exceeding a silver dollar in size, with a flat, rough, ulcerated and bleeding surface, devoid of villous projection and fading off into the surrounding bladder wall with no definite line of demarcation. It is frequently accompanied by marked cystitis. The size of a papillary carcinoma is limited only by the capacity of the bladder; squamous-cell and the more rare adenocarcinoma of the bladder infiltrate definite areas of the bladder wall, and commonly there is but one tumor present.

Various cystoscopical instruments and forceps have been devised to remove portions of bladder tumor for treatment or for diagnostic purposes. The most satisfactory of these is the cystoscopic rongeur, with which a good-sized portion of tumor may be broken off and removed for examination. This has been done in 23 of our cases in order to establish the diagnosis. Experience, however, with this method has led us to conclude that it is unnecessary and for the most part inadvisable. We have found that the removal of a portion of the tumor is not infrequently followed by considerable hemorrhage. Retention of large clots in the bladder causes considerable trouble, necessitating their aspiration or an emergency suprapubic cystostomy. Furthermore, in all cases where this procedure is used, there is the possibility of opening up channels for the extension or the

transplantation of tumor. For these reasons we have practically discontinued the cystoscopical removal of portions of tumors for diagnostic purposes, preferring rather to rely upon the cystoscopic appearance of the tumor in advising the method of treatment.

An analysis of our 131 cases shows that 10 cases received an opinion in which operation was advised, but as far as known the advice was not followed; 46 were declared to be inoperable because of the size and extent of the carcinoma and the general poor condition of the patient; 42 cases were operated upon by suprapubic cystotomy and the tumor dealt with in various ways, and 33 cases were treated primarily by endourethral fulguration.

In 4 of the 42 cases the bladder was opened and drained to meet the emergencies of retention of urine and excessive bleeding. No attempt was made to remove or destroy the tumor. One of these patients is alive; he has been wearing a permanent suprapubic drainage apparatus for a period of eighteen months and is able to pursue his usual occupation. Twenty-two cases were operated upon by excision of the tumor from the mucous membrane base, and in 5 of these the wound in the mucous membrane was repaired by catgut suture, while in 17 the base was cauterized with the Paquelin cautery. In 7 cases the tumor was so situated as to allow a resection of the bladder wall with the attached tumor without necessitating transplantation of either ureter.

Radium alone was implanted in 1 case, and in 8 the tumor was thoroughly destroyed by the d'Arsonval current, followed by 1000 to 1500 mg. hours of radium applied in needles. In 33 cases the tumor was treated by endoscopical fulguration, using the Oüdin current, and supplemented in 2 cases by radium introduced *per urethram*.

It has been impossible, unfortunately, to trace the results of all the cases treated.

Of the 5 cases treated by excision of the mucous membrane and suture of the base with catgut suture, 3 have remained well and free from recurrence eighteen months, two years and two and a half years respectively; 1 case had a severe postoperative

hemorrhage twelve hours after excision, necessitating reopening the bladder and using the cautery to control the hemorrhage; 1 case left the hospital presumably well but never returned for observation. These cases were all of the papillary variety, with definite and small pedicles easily removed by excision with subsequent suture of the denuded mucous membrane. This group is a very small one, but as far as is known no recurrences followed and there was no mortality. In the 17 cases in which the tumor was excised and the base cauterized, 5 cases were examined six months, nine months (2), one year and four years after operation and found normal; 7 cases never returned for examination after discharge and 3 suffered recurrences, 2 in three months and 1 in four years; 1 case died in two months and 1 in one year, the tumor persisting after operation.

In the 7 cases of resection, 3 patients remained well, one, two and two and a half years respectively; 1 died in four months and 3 have suffered recurrences, 2 in two years and 1 in two years and three months. Cystoscopical fulguration has been applied in the treatment of these recurrences with varying degrees of success. In 6 cases, 4 have been successfully controlled over periods of from three to eleven years, examinations at intervals of from three to six months in each case; in 2 the recurrence failed to respond and, operation being rejected, death ensued in seven months and three months respectively.

Of 8 cases treated by suprapubic cystostomy, high-frequency destruction of the tumor with the d'Arsonval current and the implantation of radium, 5 were of the infiltrating type of carcinoma and 3 of the papillary type. Of the 5 cases of infiltrating carcinoma, 1 died in six days and 3 within six months, all suffering complete invalidism from the date of operation to the time of death; 1 case of squamous-cell carcinoma has remained well three years. In 3 cases of papillary carcinoma so treated 1 died in two weeks and 2 cases are reported well, 1 of them one year and seven months and the other two years and three months. In 1 case in which radium was implanted without fulguration, death ensued in three months.

All 31 cases treated primarily by cystoscopical fulguration with the Oüdin current were of the papillary carcinomatous type, many of them showing but slight epithelial evidence of malignancy; others, definitely malignant, were advised to have a radical operation, but refused and were therefore treated in this manner. It is safe to say at the outset, in discussing this group, that where definite cystoscopical evidence of malignancy exists, fulguration is usually not successful in the presence of an active cystitis, even when the treatment is facilitated in such cases by general anesthesia. Occasionally one is surprised by an unexpected response to cystoscopical fulguration of a definitely malignant tumor, but this, however, is exceptional. Of the 31 cases treated in this manner, 4 failed to respond to treatment and died in from six months to seventeen months; 13 were followed for periods of from three to ten years: In 3 of them recurrences were the cause of the return of symptoms after an interval of apparent cure of five, five and eight years respectively. Of the 14 remaining cases, 4 were observed for one year and 10 failed to report after intervals of three to nine months following an apparent cure.

A pathological examination was secured in 23 cases, using tissue which was removed by cystoscopical forceps or rongeur, or occasionally passed by the patient, on which to base a diagnosis. It is from the study of these specimens, that we have come to the conclusion that truly benign tumors of the bladder are rare. Two cases received intravesical applications of radium per urethra in addition to fulguration. No response to treatment was obtained in 1 case and death ensued in eighteen months; the other has been an invalid for seven years but is probably cured of his cancer.

Summarizing the salient facts regarding carcinoma of the bladder, as deduced from our experience, we are able to say that:

1. Carcinoma of the bladder occurs from three to four times more frequently in males than in females.

2. A family history of carcinoma was elicited in 12.2 per cent of our cases.

3. Transient, symptomless hematuria is, as a rule, the first and frequently the only symptom of bladder tumor.

4. Such hematuria demands cystoscopical investigation; watchful waiting spells disaster.

5. A patient may live for a long time with a true carcinoma of the bladder, indicating a low degree of malignancy, and this, coupled with the recognized infrequency of metastasis, should place carcinoma of the bladder in a particularly favorable field.

6. Papillary carcinomas are ten times more frequent than infiltrating squamous-cell carcinoma.

7. Only in two-thirds of the carcinomas of the bladder encountered was any form of treatment justified. This is due to procrastination in diagnosis.

8. Practically all tumors of the bladder are malignant.

9. Cystoscopical fulguration is the best treatment of small or medium-sized, single, pedunculated carcinomas, uncomplicated with cystitis. It has little place in the treatment of semisolid, sessile papillomas, and no place at all in the treatment of advanced papillary tumors or in infiltrating or squamous-cell carcinoma.

10. A choice of operative method in the treatment of carcinoma, here as elsewhere, depends upon the situation of the tumor. Resection of the bladder with the tumor attached, where such can be accomplished without necessitating transplantation of the ureters, appears to us as the method of choice. Where resection cannot be done, excision with the cautery or high-frequency destruction is the next best procedure. The mortality of extensive resection with transplantation of one ureter, or total extirpation of the bladder with transplantation of both ureters, is extremely high and is practically never justifiable. Radium has accomplished little in the cure of carcinoma and has probably hastened a fatal termination in many cases in which it has been employed.

EMBRYOMA OF THE KIDNEY

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(By Invitation.)

The kidney during the periods of infancy and early childhood is a frequent seat of malignant disease. One of the responsible new growths has been given the general term embryoma.

Ewing defines embryoma as a tumor composed of tissue from the three germinal layers in more or less orderly imitation of a fetal tissue. This new growth has been classified in the past as sarcoma, hypernephroma and carcinoma; and it was not until after Birch-Hirschfeld pointed out the existence of a definite embryonal mixed tumor that points of differentiation were reached. The origin of these new growths is purely theoretical, varying from that of aberrant sex cell (Ribbert), to a later teratogenic terminative period, from the renal blastoma (Busse and Muus) as quoted by Ewing.

Grossly the tumors lie within a distended renal capsule with their position suggesting an origin from any part of the kidney substance; and furthermore may present themselves as entirely extrarenal. They may attain very large size, Ewing cites reported cases in which the tumors were from 35 to 40 cm. in diameter, weighing as much as 3580 grams.

Macroscopically they may be solid or cystic, in the latter case closely resembling congenital cystic kidney. In some of the later cases the entire kidney substance has given place to new growth, whereas in the earlier stages normal kidney tissue remains

in more or less isolated spots, as in one of our cases, occupying the lower pole.

When cysts appear they may be numerous, glistening, varying in size, filled with clear or straw-colored fluid, and encroaching upon the remaining kidney substance. Where but a few cysts are present they may be in close proximity to each other or isolated.

Microscopically, as described by Mallory, embryoma appears most often as a rapidly growing cellular tumor, with little stroma and fairly characteristic cells, which show no differentiation.

On the other hand, when the tumor is growing more slowly the cells are able to differentiate, and various recognizable types of cells and tissues may be formed. Thus muscle, both smooth and striated, fat, cartilage and bone may be seen. A frequent attempt at forming abortive tubules and glomeruli is noted. The individual, undifferentiated cell may be spindle, cuboidal, or giant in type, and usually presents the rapid proliferation characteristic of embryonic tissue.

When we consider the diagnosis and treatment of these new growths, we have the same problem to face that we note in dealing with malignancy in general. More difficult, if possible, for the cases necessarily come into the surgeon's hands late, and the course of the disease is very rapid.

The symptomatology is a handicap, for it is decidedly vague. Frequently the first evidence of trouble is the appearance of a tumor mass. Warnings when they do appear, as in the form of malaise, slight temperature, abdominal distention or discomfort, diarrhea or constipation, are so insignificant, that they are not looked upon seriously until too late. Loss of weight, anemia, and hematuria usually mark only the advanced cases.

The operative treatment presents two problems: (1) The fact that malignant disease has to be dealt with, which in the majority of cases had gained a firm footing; and (2) the work must be done on a subject young in years, and, many times, in poor condition. As Mixter points out, the majority of cases are under five years of age; and in his series nephrectomy gave an operative

mortality of 35 per cent, and simple exploration 44 per cent. The same author quotes the figures of Loughnane, who noted 7.7 per cent with nephrectomy, 28 per cent with simple exploration, and gives the following results obtained:

Four cases well at the end of four years, 2 at the end of two and one-half years, 3 lost track of, 2 dead from recurrence at the end of six months, and 1 dead of phthisis three months after operation. Mixter further mentions that Loughnane collected 35 nephrectomies from the London hospitals. These showed over 85 per cent recurrences, 70 per cent occurring within one year.

Although mention is made in the literature of nephrectomy with removal of the retroperitoneal gland tissue as a possible means of securing an ultimate cure, it is our opinion that such a procedure can only result in even a higher operative mortality than now exists.

In our experience, even those cases which present good risks suffer from severe shock, greater even, when we have done nothing more than a rapid and nearly bloodless nephrectomy. Very young children withstand major procedures none too well. Furthermore, we believe that the advanced cases, that is, those with anemia or any degree of cachexia are better left alone. After operation intensive *x*-ray treatment may be tried, although we have yet to see any benefits derived therefrom.

Metastasis is not common in the case of embryoma, the liver and lungs being frequently invaded when it does occur. Local recurrence is, however, the rule, and it makes its appearance usually within six months to two years. After four years, as noted by Loughnane, recurrence is rare.

The 3 cases we desire to place on record present no unusual features. Two presented cystic changes, and 1 was quite advanced. All 3 were composed of the undifferentiated type of cells. Two were operated upon by the authors, and 1 by Dr. B. H. Alton, to whom we are indebted for the privilege of reporting his case. We also desire to thank Dr. Roger Kinnicutt, Pathologist to Memorial Hospital, for the ultimate diagnosis.

Case I.—Male, aged four years, American. Normal birth and infancy. Some months before admission child's parents noted some enlargement of abdomen, but gave it no particular notice. Four days before admission child had abdominal discomfort, slight temperature and was drowsy. Following day temperature was 102° F. Admitted to hospital with diagnosis of possible appendix abscess. Urine normal, white count 11,200. Physical examination negative except for a mass, palpable in

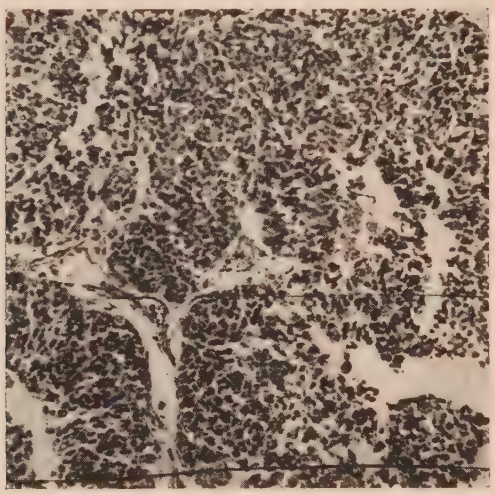

Fig. 1.—Case I. Showing masses of rapidly growing tumor cells, surrounded by a thin, loose layer of connective tissue. In places the cells show attempts at the formation of atypical renal tubules.

right kidney region. Laparotomy with right nephrectomy through abdominal route. Left kidney normal. Uneventful recovery.

Gross Pathological Report. Kidney presents several cysts occupying both poles. Also at each pole are tumor masses, each measuring about 8 cm. in diameter. These are encapsulated and walled off from the rest of the kidney substance. Tumor tissue is soft, friable and grayish in color. Scattered through it are hemorrhagic and cystic areas.

Histological Examination. The tumor consists of lobular masses of mesenchymal tissue, the lobules being surrounded by a thin loose layer of connective tissue. In places these cells show attempt at the formation of atypical renal tubules.

Diagnosis. Malignant tumor of mesenchymal origin. Embryoma.

Local recurrences six months after operation. Massive *x*-ray treatment for several weeks, death 3 months later.

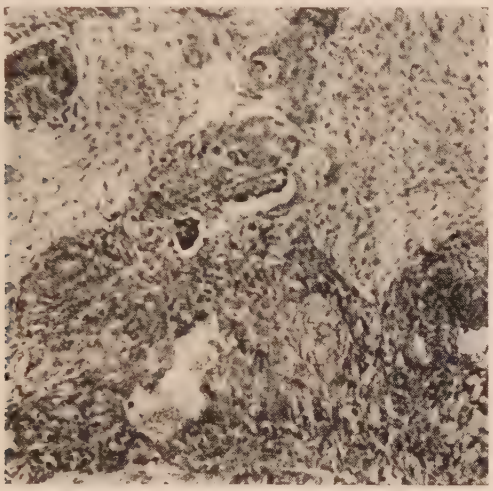

FIG. 2.—Case II. Showing lobular masses of mesenchymal tissue. The cells show rapid proliferation and with higher power many of the cells could be seen undergoing a mitosis. The connective-tissue stroma is more pronounced, with areas consisting of myxomatous cells. Here too there is a tendency toward the formation of atypical renal tubules.

CASE II.—Female, aged two years, Polish. Normal birth, breast-fed, no illnesses. Child's parents had noted enlargement of abdomen, formation of a mass and hematuria for one month before seeking medical advice. Admitted from out-patient department with diagnosis of sarcoma of right kidney. Urine loaded with blood and pus. White count, 27,300; hemoglobin, 50 per cent; red count, 4,072,000; temperature 100° F.

Polymorphonuclears, 57 per cent; small leukocytes, 17 per cent; large leukocytes, 5 per cent; transitionals, 4 per cent; eosinophiles, 17 per cent.

Physical examination showed a very pale, weak, but fairly well-nourished child, apparently normal except for a mass occupying right kidney region and not freely movable.

Abdominal exploration under ether in the hope that an inflammatory condition might be found and relieved. Advanced new growth existed however, replacing right kidney substance. The tumor was soft, grayish in color, and had adhered to the liver, duodenum and loops of small bowel.

The peritoneal cavity was filled with free bloody fluid. Left kidney normal.

Right nephrectomy after freeing tumor and thereby creating free bleeding. Profound shock noted before operation was completed. Child made an ultimate uneventful recovery.

Histological Examination. The tumor consists of lobular masses of mesenchymal tissue, the lobules being surrounded by a thin, loose layer of connective tissue. In places these cells show attempt at the formation of atypical renal tubules, and there are also area consisting of myxomatous cells. Many cells seen in mitosis.

Diagnosis. Embryoma. Local recurrence large enough to be palpable, four months after operation.

Death from recurrence March 3, 1923, six months after operation.

Case III.—Male, aged one year, American. Normal birth and infancy; no illnesses. Two months previous to entrance child's mother noted fullness in abdomen on right side below ribs. Child's operation delayed by a cough, but finally admitted to hospital with diagnosis of probable embryoma. Urine, normal; white count, 16,200; hemoglobin, 65 per cent.

Polymorphonculears, 28 per cent; small leukocytes, 18 per cent; large leukocytes, 45 per cent; transitionals, 9 per cent.

Temperature normal. Abdominal nephrectomy. Severe post-

operative reaction. Ultimate uneventful recovery. At time of removal a diagnosis of congenital cystic kidney was made.

Pathological Report. Dimensions after collapse of some of the large cysts, 10 x 6 x 4 cm. Weight of cystic fluid and speci-

FIG. 3.—Case III. Showing the gross appearance of the kidney in Case III.

FIG. 4.—Case III. The same kidney laid open. The numerous cysts appear, with the normal kidney substance showing at the upper pole.

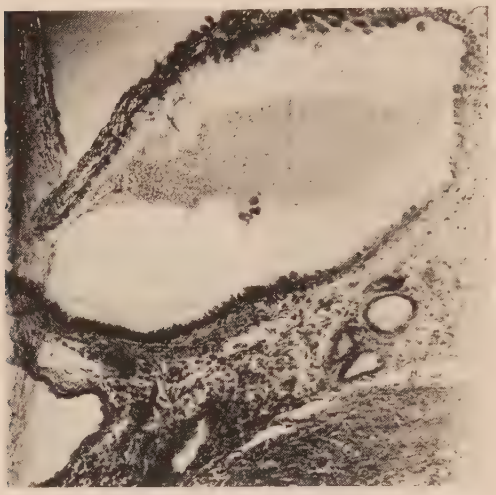

FIG. 5.—Case III. A photomicrograph of one of the cysts, to show the lining cells. The papillæ are covered with cuboidal or high columnar epithelial cells. These proliferating cells are gradually filling the cystic areas. About these cysts are layers of connective tissue, mucin-like tissue and scattered atypical tubules.

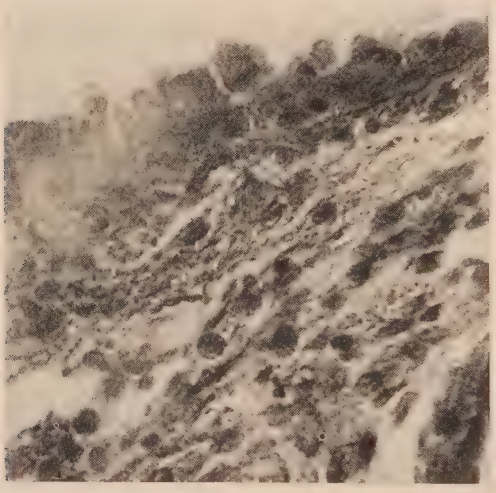

FIG. 6.—Case III. High-power of the lining layers of one of the cysts. These rapidly growing cells vary in shape from flat cuboidal to columnar epithelial cells. The underlying round and connective-tissue cells are shown.

men 275 grams. Kidney tissue pale, and walls of cysts are gelatinous, gradually becoming dense and fibrous near kidney tissue.

Histological Examination. In the remains of the kidney is a large amount of dense connective tissue, with scattered collections of round cells with deeply stained nuclei. In places the glomeruli and tubules are normal in appearance; but for the most part they are either compressed or replaced by dense connective tissue.

Below this cortical layer is a band of dense connective tissue containing no kidney structure; below this layer is looser connective tissue, mucin-like tissue and scattered atypical tubules. The walls of the cysts are irregular in outline, the irregularity due to the papillæ covered with cuboidal or high columnar epithelial cells. In the tissue adjoining the cysts are small, irregular cystic area lined with flat to cuboidal epithelium.

Diagnosis. Cystic kidney, embryoma. No evidence of recurrence at end of 3 months.

It is only fair to assume that in view of the usual course of these new growths and the difficulty of arriving at a diagnosis, the mortality will continue to be high. The results of operative interference can only be improved if earlier diagnosis can be made and earlier and more radical excision practised.

It is not at all certain that this ever can be successfully accomplished. Meanwhile it is probably best to continue doing as radical a nephrectomy as possible, so long as even a very small percentage of cases survive and remain free from recurrence for several years.

We believe, however, in view of the high mortality and high percentage of recurrences that the family should be fully appraised of the gravity of the case and the slight prospect of relief.

A REVIEW OF THE TECHNIC OF RENAL AND URETERAL SURGERY*

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It has been fifteen years since the surgery of the kidney and ureter was selected as a subject for discussion by this Association and ten years since a paper dealing with the operative technic has been presented. The choice of the Committee would therefore appear to be a good one, and I propose briefly to review some of the points in the operative technic of renal and ureteral surgery, based largely on personal experience and observation.

Kidney Exposure. I think nothing in the way of improvement in exposure of the kidney has been presented in recent years. Personally I have found the suggestion of William J. Mayo, namely, an incision beginning over the twelfth rib and dividing the arcuate ligament and the quadratus lumborum to be a valuable one. Since using this incision I have but once, and then without harm, injured the pleura and have never found it necessary to resect the twelfth rib.

I am convinced that the abdominal route is preferable to the posterior route in many cases where one is sure that nephrectomy is necessary, as in large tumors, and where other abdominal lesions are present, and in certain cases of wound of the kidney and possible associated wound of the abdominal viscera. It is much easier to remove large kidney tumors by this route and to do the operation with less likelihood of disseminating the growth by breaking into it or by manipulation. If drainage of

* Read by title.

the kidney region is necessary after this method of approach the drain can be carried out posteriorly through a stab wound and the field easily excluded by peritoneal suture. However, one should not allow the fact that he has made an abdominal incision for the exposure of the kidney to influence him to do a nephrectomy for a kidney lesion which does not require it.

Exposure of Both Kidneys. In 1906, Leonard Freeman[1] published a paper advising the exposure of both kidneys in certain cases of tuberculosis, and I should like to commend this method when, for any reason, doubt exists as to which kidney is involved or as to the involvement of both kidneys. Of course, one will have recourse to this procedure much less frequently now than formerly, owing to the improvement in diagnostic methods.

The following 2 cases illustrate the value of the method: In 1907, at the Pennsylvania Hospital, I had foolishly done a suprapubic cystotomy in a case of tuberculosis of the bladder. The bladder was so extensively involved that ureteral catheterization of the ureters could not be done either before or after the cystotomy. We suspected the right kidney was the source of the trouble, but were not certain, nor were we able to know that both were not involved. The right was first exposed and found to be extensively diseased; the left was then exposed and found to be normal; the right was removed. The double exposure added but fifteen minutes to the time of operation. Following the nephrectomy the suprapubic wound closed and the patient, a physician, made a rapid convalescence and has continued the practice of medicine ever since (sixteen years). In 1909, I operated upon him for tuberculosis of the costal cartilages. The wound healed promptly and he has developed no further tuberculous lesion.

In June, 1913, I operated upon Dr. W. for tuberculous epididymitis, one testicle having previously been removed for tuberculosis. While he was in the hospital he had an attack

[1] Jour. Am. Med. Assn., vol. xlvii, 2047.

of renal pain on the right side and passed blood. I was sure that he had tuberculosis of the right kidney and wanted to operate upon him, but he went home and I did not see him again until January, 1914, seven months afterward, when he came to Philadelphia with a discharging suprapubic fistula. He had developed a tuberculosis of the bladder and a suprapubic cystotomy had been done for retention of urine. Repeated attempts by expert urologists to catheterize the ureters, even under general anesthesia, were futile. I was sure the patient had tuberculosis of the right kidney, but I was unable to be sure the left kidney was not also involved. The left kidney was first exposed and found to be normal in every respect, except for a small fluctuating superficial mass. I thought this might be a hematoma, due to traumatism in delivery, though this had been easy. The area was incised and a creamy pus escaped from a small superficial pocket which did not communicate with the pelvis or a calix. The interior was wiped out with carbolic acid and closed by suture. The right kidney was then exposed, found to be extensively diseased and removed. The suprapubic wound healed and the physician returned against advice to his practice. He died a few weeks ago from tuberculosis of the left kidney and bladder, but had continued to practise for nine years after his operation. The interesting point in this case was that had we been able to catheterize the ureters we would have believed the left kidney to be free from disease, nothing would have been done to it and the patient probably would not have regained his health, even for a few months. William J. Mayo's method of exclusion of the infected ureter after nephrectomy by threading it into a tube, which is brought out at the lower angle of the wound, would seem to be a good one.

Incisions for Removal of Kidney Stones. Fifteen years ago, in this Association, a good deal of difference of opinion was expressed regarding the method of exposure and removal of stones from the kidney pelvis, the calices and the kidney substance, but I think today there would be a pretty general endorsement of the views expressed at that time in a paper

by Bevan, who urged pyelotomy and direct incision over the stone should it lie in a calix or in the parenchyma. The accurate localization of stones by the *x*-rays certainly removes one of the reasons advanced for longitudinal section of the kidney. The multiplicity of stones or the large size of a stone in my experience does not call for the section of the kidney. I will show an *x*-ray slide of a case in which I removed sixty stones through two incisions in the kidney substance, and I have repeatedly removed enormous stones, which filled the pelvis and extended into the calices, by carrying the pelvic incision up into the kidney substance, and am sure that this incision does much less harm, is accompanied by less hemorrhage and is followed by prompter healing than section of the kidney. Eisendrath[1] has recently described this incision and called it "enlarged pyelotomy." If it is necessary to carry the incision into the kidney substance, the retropelvic artery can be ligated before division. An interesting article on "Renal Function Following Nephrotomy," by Magoun[2] gives ample proof, from a study of a series of cases at the Mayo Clinic, that complete section of the kidney is a far more dangerous procedure, both from the point of hemorrhage and subsequent function, than pyelotomy, or pyelotomy and several small incisions through the kidney substance.

I have no cause to change my opinion on this subject as expressed in a paper read before this Association in 1913, and since that time have not once resorted to complete section of the kidney for the removal of stones. Where the parenchyma of the kidney is incised directly over the stone, the incision should extend in a line from the periphery of the kidney toward the center of the pelvis and should be closed by mattress sutures.

One of the surprising things about pyelotomy and multiple incisions is the absence or short duration of urinary leakage. This leakage, I am sure, depends more on the way the opening is made than on the way it is closed. I will show an *x*-ray

[1] Surg., Gynec. and Obstet., May, 1923. [2] Ibid.

slide of a large stone extending into the calix, removed through an incision extending up into the kidney substance. In this case no sutures were placed in the pelvic wound and yet there was only a small leakage of urine for two or three days. The incision should be made large enough for the removal of the stone and not enlarged by tearing. No forceps should be applied to the edges of the cut pelvis for retraction or for the control of hemorrhage. A clean incision heals readily while a ragged one, or one with traumatized edges, does not. I have made some very imperfect closures of the pelvic wound in which there was no leakage of urine. I am sure that in the past our gauze drains were responsible for the urinary leak. Even when a cigarette drain is used the exposed gauze at the end should not come in contact with the incision. Nearly any closed wound in a hollow viscus will leak if gauze is placed against it. In kidney and ureteral surgery soft-rubber drains should be used and lightly fixed, where wanted, with a small plain catgut suture, so that they can be easily withdrawn.

I believe that incision in the pelvis and multiple small incisions through the kidney substance are not themselves ever the cause of a fatality. We know that section of the kidney, even when no lesion is found, carries with it a definite mortality.

Bilateral Stones. The presence of stones in both kidneys, in both ureters and in one kidney and the other ureter presents a problem which it is not easy to solve.

In our last discussion of this subject, Watson, of Boston, seemed to show that the simultaneous operation on both sides was safer than operating on one side and then on the other. The factor that will go furthest in deciding this important question is the function of the two kidneys. If renal elimination is poor on both sides and urea retention high any operation is very risky. If elimination is normal either method is practicable; but even here we will meet with occasional anuria after removal of stones from one side, and such a development calls for prompt operation on the other side. In looking over my records I find it has been my custom in these cases to operate

first on the side where the function is poorer and then on the other side. The situation and the size of the stones should

FIG. 1.—K. M., Pennsylvania Hospital, No. 197, 1922. This plate represents phosphatic stones filling the pelves and extending up into the calyces in such a manner as to give the appearance of a pyelogram and has been often so interpreted. Stones removed from right kidney by Doctor Billings, July, 1922. Stones removed from left kidney, March, 1922, through pyelotomy and from incisions through kidney substance. A handful of stones was removed. No sutures. Discharged March 31. Death occurred two weeks after she returned home.

FIG. 2.—F. D., Pennsylvania Hospital, No. 334, 1921. Large stone removed in three pieces through pelvic incision. One suture. No record of urinary leakage. Discharged on fourteenth day.

not influence us too much, though, as a rule where there is a renal stone on one side and ureteral stone on the other the ureteral stone should be made to pass, or be removed before

FIG. 3.—N. C., Pennsylvania Hospital, No. 407, 1921. Large ureteral stone removed March 16, 1921, by combined intra- and extra-peritoneal ureterotomy. Peritoneum accidentally opened, but opening utilized to fix stone and ureter during removal. No sutures; urinary leakage for about a week. Phlebitis only postoperative complication.

FIG. 4.—N. C., Pennsylvania Hospital, No. 449, 1921. Sixty stones removed March 14, 1921, by pyelotomy, and two incisions made directly over stones. No sutures in pelvic wound. No leakage of urine. A year previous these stones were thought to be gall-stones and a negative exploration of the gall-bladder made by another surgeon, who found the stones to be in the kidney but did not remove them. On removal these stones were facetted and in shape and color were exactly like gall-stones.

doing anything to the kidney stone. One of the slides I show illustrates this point; although there was a very large stone in the right kidney, causing a great deal of pain and fever, with a large quantity of pus, the function of this kidney was better

FIG. 5.—S. D., Pennsylvania Hospital, No. 752, 1923. Ureteral stone removed by extraperitoneal ureterotomy April 3, 1923. No sutures, some drainage but urinary leakage questionable. Kidney stone removed by enlarged pyelotomy April 24, 1923. No sutures. Discharge had urinary odor for three days, requiring change but once a day.

FIG. 6.—M. T., Pennsylvania Hospital, No. 1476, 1923. Two large facetted stones removed May 15, 1923, by pyelotomy. Pelvis sutured. Urinary odor on dressings for three days only.

than that of the left, the ureter of which was partially obstructed by a stone which was causing no symptoms. The ureteral stone was removed and twenty-one days later the stone in the right kidney was removed through a pelvic incision carried up into the kidney substance for a short distance. The kidney wound was sutured, but no sutures were put in the pelvic wound. Urinary leakage from the ureteral wound was only of two or three days' duration and from the right kidney for about the same period.

FIG. 7.—M. M., Jefferson Hospital, B–5242, 1912. Large stone; upper third of kidney normal, lower two-thirds destroyed. Sac containing stone drained after closing its communication with the pelvis. Late urinary leakage for a week.

Fluoroscopical localization of stones on the operating table has been perfected by Braasch and Carman,[1] and in certain cases it must prove of inestimatable value, as we have all been embarrassed by being unable to find a stone which has been apparent in a plate, or by being unable to assure ourselves that all stones, or all particles of a stone, have been removed. I have not as yet used this method of localization.

[1] Jour. Am. Med. Assn., 1919, vol. lxxiii.

NEPHRECTOMY. Nephrectomy for stone is rarely necessary and should never be done unless we are quite sure the kidney is hopelessly damaged by infection or hopelessly injured by manipulation. Recently, for the first time, I was obliged to do a nephrectomy for a single stone because of injury I had done the kidney in delivery. It was in a second operation for stone, and the adhesions were very thick and dense. The nephrectomy was done because of bleeding.

One reason for being conservative in regard to the removal of the kidney is the fact that stones are very apt to be present or to develop in the other kidney. Braasch found bilateral stones in 1 out of 6 cases of renal stone at the Mayo Clinic. Another justification for conservation of the kidney is that it is difficult to prognosticate the future function of the kidney by a consideration of its condition at the time of the operation. One case which I had will illustrate these points very well:

I first operated upon Mrs. J. fourteen years ago (1906). She had an enormously distended and infected right kidney, due to a large stone in the lower ureter. It seemed as if all secreting substance had been destroyed, except a little good kidney structure at the upper pole. The kidney was drained and the ureteral stone removed by the combined intra- and extraperitoneal method. The patient made a good recovery and there was no leakage from the ureter, which was not sutured. The kidney condition certainly might have justified a nephrectomy.

Four years later (1913) I operated upon this patient for a strangulated femoral hernia. Eleven years after the first operation (1920) I again operated upon her for a large stone filling the pelvis of the left kidney and extending up into the calices. The kidney was badly infected and distended with foul pus and urine. The stone was removed in many pieces through a pelvic incision. Nephrectomy seemed indicated here, but we had been unable to catheterize the ureters and did not know the function of the right kidney. The urinary output after this operation was normal and the patient made a good recovery.

Eighteen months after this operation (1921) I operated upon Mrs. J. again for acute infection of the gall passages with jaundice due to stones; a cholecystectomy was done and the patient recovered without any kidney or other complications, although there was a fair-sized stone in the lower pole of the left kidney at the time, evidently the result of leaving a small piece of stone at the last operation.

In May, 1922, I once more operated because of symptoms of intestinal obstruction, due to adhesions, and again she made a good recovery. This poor woman's life may not have been a happy one during the past fourteen years, but I think it illustrates the wisdom of avoiding nephrectomy in some cases where it would seem to be indicated.

Removal of Stones from Lower Ureter. Strides have been made in removal of stones from the ureter since our last discussion of this subject. The non-operative method, the dislodgment of the stone with the ureteral catheter, resulting later in its passage, has removed from the field of operative surgery about one-half the cases of ureteral stone and represents a great advance in treatment. The size of the stones sometimes made to pass by this method is quite surprising. But the remarkable success obtained does not mean that this method is always indicated or that even its trial is always justified. If attempted in cases not suitable for it, it may do harm and will in any such case put the patient through an unnecessary amount of discomfort. Braasch[1] says that when a stone has been lodged in the lower ureter from three to six months, or is more than 2 cm. in diameter, the possibility of dislodgment with the catheter and its subsequent passage is greatly diminished. Where there is a serious infection of the ureter or kidney I think the method should not be used. However, in the majority of cases if the stone is not too large and the evidence of infection slight, several attempts should be made to dislodge the stone. If these attempts are followed by

[1] Mayo Clinic, 1919, xi, 267.

much reaction they should be discontinued and the stone removed by operation. If the stone is not too large to pass and its arrest in the lower ureter of short duration, neither dislodgment nor operation should be done, but a reasonable chance given it to pass. The drinking of large quantities of water will undoubtedly facilitate its passage.

In endeavoring to decide between dislodgment with the catheter and operation, one of the factors to be considered is experience. I would prefer the operation in experienced hands rather than dislodgment by an inexperienced cystoscopist, and the dislodgment by a good cystoscopist than operation by a surgeon without experience in this field. It may then very readily become a question of the man and not the method.

The mortality of the operation of removing stones from the ureter is practically *nil*. Judd[1] reports 400 such operations from the Mayo Clinic with but 1 death. I have personally removed stones from the lower ureter in 22 cases, with no deaths, and the most serious postoperative complication was a phlebitis. In none of these was there obstinate urinary leakage or infection. In the majority there was no leakage of urine and in others it lasted from two to ten days. The end-results have been, I believe, remarkably good, though I have not been able to follow up all my cases. The technic of this operation has always interested me and I have presented to this Association and elsewhere several communications on the subject.[2]

The earlier routes for the removal of stones in the lower ureter, the vaginal and sacral, I think have been very properly abandoned and I doubt whether even the vaginal route is ever justified, because it has been followed by more and longer urinary leakage than any other.

The most satisfactory incisions are a muscle-splitting-one above and parallel to Poupart's ligament and the rectus sheath incision (Gibson's incision). When the peritoneum is reached it

[1] Ann. Surg., 1920, vol. lxxi.

[2] Ann. Surg., May, 1906; Surg., Gynec. and Obst., May, 1908; Ann. Surg., August, 1913.

is reflected toward the pelvis until the iliac vessels and the pelvic wall below them are well exposed. The ureter adheres to the peritoneum and is reflected with it, making it sometimes difficult to identify and grasp. Its location can often be made out by palpating the stone, and if not, it is most easily identified at the point where it crosses the iliac vessels. I have always located the stone with the finger before mobilizing or opening the ureter, and if this is not readily done I make a button-hole in the peritoneum, pass one or two fingers through it, locate the stone and push it up with the ureter until it can be seen or readily felt in the extraperitoneal wound, where, without removing the finger which supports the stone from the peritoneum, the ureter is incised and the stone removed. A gauze sponge is placed immediately over the wound in the ureter to take up any escaping urine and the ureter then closed with sutures, or a rubber-covered drain is fixed near the incised ureter without suturing. The finger in the peritoneum is now withdrawn and the button-hole closed.

Extensive mobilization of the ureter, I think, is a mistake and apt to delay healing. It can be avoided by using one or two fingers on the peritoneal side for support of the ureter in difficult cases. I have opened the peritoneum in about one-half my cases, but never do so if I can easily find and remove the stone without doing it. In no case has the stone ever been removed through the peritoneum and in no case has there been a peritoneal infection. I am sure the combined intra- and extraperitoneal operation cuts down the time of the operation enormously in difficult cases. Twice in women where the stone was very low in the ureter, an assistant's finger in the vagina has been of great help in bringing the stone up into view in the extraperitoneal wound. A dilated ureter makes its identification much easier and greatly facilitates the removal of the stone. In these cases I think it is often better to open the ureter a little above the stone and remove it with the Mayo common-duct forceps. If the stone can be pushed up to a higher point in the ureter without too much traumatism, it is better to do

so, and to remove it through an incision at this point. In nearly all my recent cases I have put no sutures in the ureteral wound, many of which have healed without leakage and none of which have had any more leakage than in the cases where the wound was closed. The ureter should not be so displaced or twisted that the incision is made in its floor. The reason why leakage has been so troublesome when stones were removed through the vagina is probably because the incision is made in the floor of the ureter.

Everything that has been said about incision, sutures and drainage in pyelotomy applies equally to the ureter.

In closing, I should like to commend the advantages of the combined intra- and extraperitoneal operation for stones in the lower ureter, where the stone is not easily found and removed through the extraperitoneal wound. In my own experience it has made many difficult operations comparatively easy and has saved the ureter much unnecessary traumatism.

In order to rectify the misapprehension which has appeared in some text-books. I should like to say that I have never advocated the removal of stones through the peritoneum and have never removed one by this route.

THE OPERATION OF CHOICE IN THE SURGERY OF THE KIDNEY

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In considering operations upon the kidneys there is one point of paramount importance which must be borne in mind and that is, that we are dealing with organs whose function is absolutely essential to life. The choice of operative procedure, therefore, cannot be governed by considerations which may govern the surgical treatment of other paired organs or of diseases of the gall-bladder, of the appendix or even of the genital organs. Whatever may be the final decision as to the function of the gall-bladder, for example, or as to the part played in the body economy by the secretions of the ovaries or the testicles, the fact remains that these organs can be dispensed with and that life can proceed with more than a fair efficiency. Fortunately there are two kidneys, and if one is permanently impaired or removed, the other can by certain compensatory changes take care of its increased load.

The essential character of the kidneys, therefore, makes the following the outstanding considerations which must be met in considering any surgical procedures upon them:

1. To establish definitely the presence or absence of a second kidney.

2. If one organ is impaired, to determine the functional capacity of the other.

3. If both organs are impaired, to determine whether or not the impairment of one is of a sufficiently minor degree to allow it to undertake the whole functional load.

4. If both are impaired, to determine whether or not the impairment of both is so slight, that first one and then the other may be repaired.

It should be borne in mind always that no operation upon the kidney should be considered a minor operation. Even pyelotomy for the removal of a stone, unless the stone lies with comparative freedom entirely within the pelvis, may be followed by the injury of the calyces and adjacent kidney tissue to such an extent as to diminish seriously the functional capacity of that kidney.

The outstanding conditions for which surgical procedures upon the kidneys may be demanded are tumors—which are almost always malignant; stones; infections—among which tuberculosis presents a particularly interesting problem; pyonephrosis; and hydronephrosis. In each of these conditions except in the cases of those stones which, as is noted above, may be readily removed by means of a pyelotomy, a choice between a nephrotomy and a nephrectomy must be made. Before considering these various conditions in detail, it is hardly necessary to emphasize the point that in every case the functional capacity of both the diseased and of the supposedly intact kidney must be rigidly determined. Some surgeons believe that if the kidney will function up to 35 per cent of its normal capacity without liability of metastatic influence on other structures, it should be saved. Also it should be emphasized that in the determination of the identity of the suspected abnormality every diagnostic measure at our command—blood chemistry, dye excretion, roentgenograms, and urinographs—must be utilized.

The following comments regarding the operation of choice for the various pathological conditions included in this discussion are based upon my personal experience in 628 cases of surgical diseases of the kidney and 394 operations.

Tumors. As I have noted above, tumors of the kidney are nearly always malignant. Even a papilloma which may appear frankly benign may be followed by a malignant recurrence. In the case of a tumor of the kidney, therefore, provided there

is a second kidney and that kidney possesses good or fair functional capacity, nephrectomy should be performed, and if the tumor originated in the pelvis of the kidney the ureter on that side should be removed also.

In performing a nephrectomy for tumors of the kidney, as in all cases of malignancy, there should be as wide a resection of the tissue as possible, including the fatty capsule, and in most of the cases the operation should be followed by deep *x*-ray therapy. In some cases of sarcoma, it is remarkable how rapidly the tumor will diminish in size after the use of *x*-ray and radium, but I have never seen one of these cases cured in this way. Although in a large percentage of the cases there is a recurrence following operations, nevertheless there are a sufficiently large number of recoveries to warrant the opinion that surgical removal is the method of choice.

Stones. The question as to what should be the procedure in cases of stone in the kidney or ureter has been under vigorous discussion for a long time. The cystoscope and ureteral catheter have made it possible to remove a fair percentage of stones situated in the ureter by manipulation, but such attempts have been of little avail in the removal of stones in the kidney. Because a certain group of skilled manipulators have been fairly successful in removing stones from the ureter by means other than the open operation, advocacy of this method has led to an unwarranted effort on the part of many less skilled operators and much damage has been done with no corresponding benefit.

Having decided that an open operation is the method of choice in the removal of a stone in the kidney, what type of operation should be performed? Both clinical and experimental researches have shown that nephrolithotomy is attended by a higher mortality rate and a greater loss of function than pyelolithotomy. In only the exceptional case need the kidney be completely divided for the removal of a stone. A free opening of the kidney pelvis, extending the incision up into the cortical substance if necessary, as recently shown by Eisendrath, will permit the removal of a large branching stone with little or no hemorrhage

and a minimum destruction of kidney substance. In the occasional case it may be easier to remove an imbedded stone by a localized incision or puncture in the kidney, directly over the stone, but the bisection of the kidney is a destructive operation which should be abandoned. The use of the fluoroscope as recommended by Braasch and Carman for the determination of the location of fragments or small stones is novel and has undoubted merit. When this cannot be done, the taking of a film with the kidney exposed as suggested by Quinby is another method of determining whether there are any remaining fragments. Irrigating the pelvis and calyces with syringe and catheter when the pelvis is opened will often remove small fragments which might be difficult to find by manipulation.

When stones are present in both kidneys the decision as to the method of intervention becomes more difficult. The location and not the relative size of the stones may be the determining factor as to which side should be operated upon first. A stone obstructing the ureter will more definitely impair the kidney function than will a large branching calculus which although it may fill the kidney pelvis and calyces, yet does not definitely obstruct the ureter. Cases of bilateral stones should practically always be operated upon, for although patients may live for many years with large stones in both kidneys, the stones will eventually destroy life if allowed to remain and a careful preparation and operation is not necessarily attended with a high mortality. The prevention of the recurrence of stones in the kidney presents a more difficult problem than their treatment.

Infections. In cases of infection of the kidney it is not always easy to decide whether or not to operate. The presence of tubercle bacilli in the urine, especially if unilateral, used to be and still is with many a sufficient criterion for operation. I do not believe so radical a stand should be taken. If there is a definitely localized tuberculosis on one side with abscess formation, there is no question as to the method of procedure and we all know the happy results obtained in these cases. But in those cases in which the only lesions found at operation are small

tubercles, mostly beneath the capsule, with no definite walling off, operation often results only in a rapid lighting up of a general miliary tuberculosis and a speedy dissolution. The problem in such cases is, primarily, one of diagnosis, and I am convinced that if a correct diagnosis can be made by waiting, it is far better to wait than to operate upon some of these cases too early. I believe that we shall be able to work out a method whereby an accurate diagnosis can be made before operation is instituted.

If operation is decided upon, nephrectomy is, of course, the operation of choice. Even in cases of bilateral tuberculosis the removal of the more extensively involved organ will alleviate the symptoms. In cases of tuberculosis, however, operation is but one step in the course of treatment. The postoperative management of the case and the use of general hygienic measures play an important part in obtaining the best results.

In those cases of infection which are metastatic in origin, it is difficult to decide what type of operation should be performed, if, indeed, one should operate at all. Personally, I do not operate on the so-called multiple septic infarct cases at once. Often these cases, even with very high temperatures and with involvement of both kidneys, will recover without surgical intervention. If well-defined localized abscesses develop, however, and the other kidney remains free, a nephrectomy should be performed.

Hydronephrosis presents a most interesting problem. Before Hinman performed his important researches in connection with this condition, we felt that it was sufficient to remove the cause of the ureteral obstruction whatever it might be in order to restore the function of the kidney. We now know, however, that in these cases the opposite kidney has hypertrophied and compensation has taken place. Removal of the obstruction does not restore to the kidney its functioning power so that instead of a working organ we still have, in many cases, only a large sac with little functioning substance. If infection is present, this shell is a definite menace to the other kidney, which is already doing the work of both. Therefore, instead of simply

removing the cause of the obstruction if it has existed for any length of time, the only safe procedure is to perform a nephrectomy.

It will be noted in the above discussion that we would appear to be favoring nephrectomy almost to the exclusion of nephrotomy and it is true that we are increasingly coming to adopt the point of view that provided one functioning kidney remains the dangers of nephrotomy are not justified. These dangers are briefly as follows: persistent hemorrhage; failure of the wound to close with the consequent leaving of a constantly infected urinary fistula; permanent damage to the kidney structure by contracting scar tissue; diminished resistance of the kidney operated upon; the increased danger of the recurrence of pathological conditions whether stone, infection or tumor; and finally the inevitable effect of a prolonged suppuration of one kidney upon its fellow.

Since the purpose of this paper is simply to present certain principles underlying the choice of operation, I have made no attempt to give detailed descriptions of the technic of the various operations.

Conclusions. No inclusive statement can be made regarding the operative management for any type of kidney lesion. All the factors in the individual case must be considered in making a decision as to the proper operative procedure. If the proper preoperative precautions be taken and a careful choice of operation be made, the mortality rate of operations on the kidney will not be high. In my own series the mortality rate has been 1.7 per cent.

Bibliography

Braasch and Carman: Renal Fluroscopy at the Operating Table, Mayo Clinic, 1919.

Eisendrath, Daniel N.: Technic of Enlarged Pyelotomy for Renal Calculi, Surg., Gynec. and Obst., 1923, xxxvi, 715.

Foster, G. S., and Miller, S.: The Surgical Kidney: A Systemic Method for Determining the Diagnosis and Modus Operandi, Int. Clin., 1921, ii, 203.

THE CONSIDERATION OF CERTAIN FEATURES OF RENAL CALCULUS

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The wide variation observed in the pathology of renal calculus accounts for the great irregularity of its clinical manifestations. Calculus may be single or multiple, in one or both kidneys, possessed of rough or smooth surface, situated in either the parenchyma of the organ or in the pelvis, or in both places simultaneously. If in the parenchyma, it enjoys little if any movement; on the other hand, in the pelvis, small calculi, if not adherent to its wall, usually are freely movable and if too large to pass through the ureter may intermittently occlude the pelvic outlet. Furthermore, calculi vary in the rapidity of their formation, and their growth may be intermittent as the character of the urine becomes more or less favorable to the precipitation of its mineral constituents. That calculi should form simultaneously in both kidneys is a natural inference, yet such an occurrence is the marked exception, and is perhaps accounted for by the fact that the chemistry of the urine collected by ureteral catheterization from either kidney does not always show the same composition and may vary to such an extent as to actually differ in reaction.

Renal calculi, through their irritation, cause an intermittent, non-infectious inflammation of the mucous membrane of the pelvis, or, if in the parenchyma, of the connective-tissue stroma of the organ, as well as a productive inflammation of the perinephritic connective tissue proper. This latter condition leads

to the formation of more or less dense adhesions between the kidney and its investing capsule, because of which, in the course of the operation for the removal of the stone, the delivery of the kidney to the surface of the wound may be greatly impeded. By the contraction of this same tissue the pedicle of the kidney may be shortened, and in one instance observed by the writer this contraction was so marked that the poles of the kidney were approximated. The kidney pelvis in consequence was so concealed from view that the calculus within its cavity could only be removed through an incision in the kidney parenchyma. On the other hand, total absence of any change in the perinephritic tissue is well demonstrated in Case I, in which both subjective and objective symptoms indicated a freely movable kidney. The calculus was detected in the course of routine *x*-ray examination and easily removed through the usual incision in the posterior wall of the pelvis. The writer in the past has operated on many cases of movable kidney and in no instance was a calculus found in the exposed pelvis.

The writer refrains from any reference to the pathological changes due to pyogenic infection in a kidney containing calculi. Such a condition usually develops, if at all, in the later stages of the lesion and after the calculi, by obstruction, have caused distention of the pelvis and calices.

The gross pathology of renal calculus has thus been briefly outlined for the purpose of emphasizing the difficulty of correlating the subjective symptoms into well-defined clinical groups. These subjective symptoms, therefore, while of relatively little diagnostic value, are at least important in leading to *x*-ray examination, and for that reason deserve study and consideration. In omitting their exhaustive enumeration, it is, nevertheless, important to call attention to the fact that pain, unquestionably the most constant symptom, is subject to frequent variation. In place of the typical lumbar pain radiating downward and forward along the course of the ilio-inguinal nerve, this symptom may be more or less localized and even referred anteriorly to a point above or below the level of the

navel. This is of importance in the differential diagnosis of renal calculus from inflammatory conditions of the gall-bladder, duodenum and pancreas, and strongly emphasizes the need of *x*-ray examination in these baffling conditions. Rarely pain is conspicuous by its absence. In one such instance, recently observed, the patient's attention was attracted by a hematuria (Case XV). As is well-known, this symptom, especially in those beyond middle age, strongly suggests malignancy of the bladder. Moreover, at any age, it may be the first indication of a hypernephroma. Fortunately for the patient (aged fifty-eight years) investigation of the bladder proved normal, while an *x*-ray of the lumbar region showed a well-defined calculus, apparently in the parenchyma of the kidney. The discovery of a renal calculus may be entirely accidental. This is well illustrated in the following history (Case XIII):

A man, aged thirty-five years, apparently in perfect health, applied for life insurance. The urine on microscopical examination was found to contain a small amount of pus, which on cystoscopical examination was found to issue from the left ureter. An *x*-ray then taken showed the shadow of a calculus the size of a lima bean, which was successfully removed from the kidney parenchyma.

While renal calculi may thus form without symptoms, the writer believes that this is very much less frequent than the corresponding formation of gall stones.

Rarely pain due to a renal calculus is referred to the opposite kidney. This variation, usually considered to be due to some abnormality in the reflex path, is well illustrated in Case XII, in which a different explanation is suggested by the subsequent history of the patient. After the removal of the calculi from the affected left kidney the pain persisted at intervals on the right side, occasional *x*-ray and ureteral catheter examinations proving negative until four years after the operation, when multiple calculi were demonstrated in a radiogram. The explanation referred to is that the right-sided pain was due to the irritation of the urine of the right kidney even before any pre-

cipitation of its mineral constituents had taken place. The exact nature of the change in the chemical composition of the urine responsible for the pain it is impossible to state.

The surgical treatment of renal calculi depends upon their number, location, whether the lesion involves one or both kidneys and the condition of the kidney itself. Single or multiple calculi in the pelvis are most easily and safely removed through an incision in the posterior pelvic wall. This method of approach has gradually superseded the removal of calculi in this location through the kidney parenchyma, for the danger of a persistent urinary fistula after the former proceeding proved largely imaginary, while the risk of postoperative hemorrhage from divided kidney tissue, occasionally of such an extent as to require immediate nephrectomy, is obviously avoided. The exposure and removal of calculi in the renal parenchyma are possible only after division of the overlying kidney tissue. In this group of cases the *x*-ray has proved of the greatest value in determining the number of calculi and their approximate position. This information ordinarily directs the point of attack and defines the limit of the operation, so that unnecessary exploration is avoided. The procedure is, however, not always so simple, for, as in the case of fractures, the interpretation of *x*-ray plates is occasionally misleading and confusing, especially when multiple calculi overlap. If for this or any other reason the locating of the calculus or calculi is difficult, valuable assistance is given through the bimanual palpation of the kidney in the course of the operation. In this maneuver the kidney is gently compressed, from above downward, between the tip of the little finger, inserted through an incision in the posterior pelvic wall, and the index finger of the same or opposite hand on the external surface of the kidney. This method of palpation first advocated by the writer in a paper published in 1906, has proved most serviceable. Except in those cases of long-standing calculi in which fibrosis has developed, the cortex of the kidney so compressed feels both thin and soft, and calculi can easily be felt even if of small size.

The nature and direction of the incision of the kidney tissue through which the calculus is to be removed depends upon its character and size. Large, branching calculi are best approached through an incision longitudinal along the convex border of the organ. For small calculi the writer prefers an incision at right angles to the long axis of the kidney. In both it is important to remove the calculus without fracture in order to avoid the possibility of recurrence from a small fragment left *in situ*. After the removal of the calculus the divided kidney tissue is best approximated with one or more mattress sutures of catgut. Nephrectomy is always justified in calculous pyonephrosis and in cases in which the kidney parenchyma is studded with a large number of calculi provided that an *x*-ray examination shows no calculi in the remaining kidney and that satisfactory renal sufficiency can be demonstrated in the urine collected from that organ by ureteral catheterization. If a nephrectomy is to be done, it is well to remember that the pedicle of the affected kidney may have been shortened by the contraction of perinephritic tissue associated with long-standing inflammation of both the infectious and non-infectious types, and that, especially on the right side, which normally has a shorter pedicle, a subcapsular removal of the organ may prove the safest measure. When both kidneys are involved it may be difficult to determine the appropriate treatment, especially if the calculi are multiple. In general, the removal of the calculi at separate times may be attempted if they appear to be limited to the pelvis of the kidney, or if, in the parenchyma, their number is sufficiently small to justify a reasonable expectation of operative success. Nephrectomy of the more involved kidney is rarely justifiable except for pyonephrosis and then only when adequate renal sufficiency of the remaining organ can be demonstrated.

In general, the immediate operative results in cases of renal calculus are very satisfactory, especially in the removal of calculi situated in the pelvis only. This operation causes little if any disturbance in the function of the kidney, the urine not

being preceptibly diminished in quantity and containing during the first twenty-four hours a considerable quantity of clotted blood. During the first day or two there is a little discharge of urine in the dressing which, after that interval, entirely disappears. That the operation is not devoid of risk, however, is shown by two fatalities, one in the writer's series of cases and the other in that of a skilled and experienced colleague. In the former instance, the removal of a calculus through an incision in the kidney pelvis, a sudden rise of temperature appeared after an uneventful convalescence of eleven days and varying between 105° and 108°, continued for five days until the patient's death. The wound drained satisfactorily during the entire period and no subjective or objective symptom could be elicited to account for the unusual course. Unfortunately, no autopsy could be obtained. The other case, seen in consultation by the writer, occurred in a strong robust adult, aged twenty-one years. Twenty-four hours after operation shock suddenly developed, with death on the following day. The removal of the calculus through a pelvic incision had been quickly done with a minimum of kidney manipulation. An autopsy showed no hemorrhage, no involvement of the kidney and no lesion that could account for the unfortunate result.

While, as has been stated, no immediate change in the function of the kidney from which the stone has been removed is apparent, the possibility of the gradual development of diminished excretory power of the affected organ must be taken into account. Routine postoperative ureteral catheterization continued for a sufficient length of time would unquestionably decide this question. It has only been done in a few of the writer's cases and usually some months after the removal of the stone in which the recurrence of lumbar pain pointed to possible recurrence. In these scattered instances this procedure showed symmetrical kidney excretion. Another, although uncommon, proof of the persistence of normal kidney activity is furnished by the postoperative renal fistula. In Case VI such a fistula discharging a considerable amount of urine per-

sisted for over a year after removal of a calculus in the pelvis through an incision in the kidney tissue.

The writer wishes to emphasize the need of careful investigation of the chemistry of the urine of the affected kidney both before and after operation, comparing the respective analyses with each other and with the urine of the normal side in order to discover evidence that, however imperfectly, may indicate the character of the changes in the metabolism that predispose to, if they do not actually cause, the formation of calculi.

No part of the subject is more interesting than the consideration of recurrence after operation. The complete removal of one or more calculi from the kidney parenchyma or pelvis relieves the patient of one or more foreign bodies without in any way affecting the cause of their formation. It is not strange, therefore, that calculi recur. Perhaps it is strange that recurrence is not more frequent. Recurrence, while more common after removal of calculi from kidney parenchyma, may also occur after the removal of even a single calculus from the pelvis. To this class belongs Case XI, in which after a succession of recurrences in different locations a terminal infected pyonephrosis developed, requiring nephrectomy. The writer is especially apprehensive of recurrence after removal of calculi in the parenchyma, for the reasons that in this situation calculi are so frequently multiple and that one or more may be so small as to escape detection not only by means of the *x*-ray but by careful palpation of the kidney itself in the course of the operation. Strictly speaking, such a condition is not a recurrence but an inability to detect calculi in the early stage of their formation. The writer believes, however, that a true recurrence may develop, due to the excusable failure to relieve the predisposing and exciting causes of altered metabolism. That the parenchyma, after the removal of calculi, may remain free from recurrence, has been the writer's experience in half a dozen patients, who have shown no subjective symptoms or visible urinary changes for periods of from two to sixteen years. Such evidence is obviously faulty without the support of *x*-ray

and ureteral catheterization. However, the patient free for sixteen years was accepted as a good insurance risk, much, it must be confessed, to the surprise of the writer. The constant shifting of urban population is responsible for the failure to trace other patients operated upon for this condition, especially those treated in hospital wards. The fact, however, that few cases of recurrence in patients operated upon by other surgeons have been encountered indicates at least that recurrence on the whole is uncommon. Nevertheless, it must be conceded that complete removal of all calculi, even of those limited to the kidney pelvis, does not by any means ensure a permanent cure. In spite of measures to prevent recurrence, such as the regulation of the diet and the use of a sufficient quantity of alkaline salts to maintain a neutral or slightly alkaline urine, continued indefinitely, recurrence may occur. In this respect renal calculus is analogous to gastric ulcer in which, no matter how radical the operative treatment, even the most careful subsequent hygienic and dietetic measures fail at times to prevent recurrence.

While the necessity for the radical removal of renal calculi can never, in all probability, be avoided, future progress in the treatment of this condition surely lies in the development of the knowledge of those changes of tissue metabolism which predispose to their formation and to the discovery and adoption of suitable measures to regulate and maintain normal metabolic changes in the tissue cell.

Case I.—Female, aged fifty-two years. History of dull lumbar pain, especially on walking, thought to be due to movable kidney. After an attack of acute appendicitis the pain disappeared until two and a half years before admission to the hospital, since when it has persisted until the present time. There has been increased frequency of micturition with occasional hematuria. A calculus, found on *x*-ray examination, rough in character and free in the pelvis of the kidney was removed by pyelotomy, with relief of the local symptoms.

Case II.—Adult male. Several similar attacks to the present one for the past five years. Present attack began today, before admission to the hospital, with vomiting, chills, headache, bloody urine and pain in the left lumbar region. There was also increase in frequency of micturition. On operation a stone, three-quarters of an inch in diameter, was found in the pelvis of the left kidney, concealed by the approximation of the kidney poles, curved over by the contraction of perirenal connective tissue. The kidney was delivered after the removal of the twelfth rib. The stone was felt but could not be attacked through the pelvis, owing to the overlying kidney tissue. A silk ligature was passed upward through an incision in the pelvis through the overlying kidney tissue, which was then divided by a sawing motion. The calculus was then removed and the profuse bleeding from the divided kidney tissue was easily controlled by suture.

Case III.—Female, aged forty-three years. History of frequent micturition for eight or nine years, with dragging pain in the legs. Five months ago was said to have voided gravel. Two weeks after an uncomplicated removal of an intraligamentous cyst on the right side, severe pain developed in the left ileocostal space, radiating to the bladder, with local tenderness and constitutional symptoms of fever. Gradual subsidence in three days. Ten days afterward, onset of attack with sudden sharp pain over the right kidney, with nausea, vomiting, marked diminution in the quantity of urine and the formation of a mass in the right hypochondrium the size of an orange. Catheterization of the left kidney showed a normal condition while that of the right showed obstruction four inches above the bladder.

On operation a pyonephrosis was found with calculi in the sac and the ureter four inches below the brim of the pelvis was found to be completely blocked by a mass of calculous detritus. The purulent material had a distinct colon odor. Nephrectomy was done. There was no apparent connection between the

occlusion in the ureter and the intraligamentous cyst, which was excised three weeks before the nephrectomy. Recovery.

CASE IV.—Female, aged twenty-four years. In September, 1910, a stone was removed from the pelvis. One month after operation, increased frequency, with burning pain, was noticed, and has continued for the past six months. For the week before admission there was a recurrence of the old lumbar pain which existed prior to the removal of the calculus, with purulent intermittent urine but no blood. *X*-ray showed two calculi in the parenchyma. Nephrectomy. Examination of the kidney showed multiple calculi in the parenchyma with evident fibrosis, and on microscopical examination, tuberculosis with degeneration of the parenchyma.

CASE V.—Male, aged thirty-two years. Fourteen months ago the left kidney was explored by another surgeon after three attacks of severe stabbing pain in the left flank radiating to the left groin and scrotum. The operation was terminated, uncompleted, on account of hemorrhage. Five months later had a recurrence of the pain with abscesses in the scar. A large branching calculus in the pelvis of a pyonephrotic kidney, which had been disclosed by an *x*-ray, demanded a subcapsular nephrectomy, from which the patient recovered.

CASE VI.—Male, aged fifty years. For the past ten years patient has had attacks of pain, passing of stones, of increased frequency of micturition with burning sensations at the end. Three stones found on *x*-ray were removed by nephrotomy from the right kidney pelvis, to the wall of which they were adherent. Kidney tissue was sutured. Several months after the operation similar symptoms developed on the left side, which continued for two years, when through a left nephrotomy a stone was removed from the parenchyma of the left kidney to which it was so adherent that it was fractured in its removal. Following this operation the patient developed a lumbar urinary

fistula which continued to discharge for nine months. After the second operation, catheterization of the right ureter showed normal urine and examination with the *x*-ray failed to disclose any calculus. One year later a second catheterization and *x*-ray showed a normal condition of both kidneys.

Case VII.—Male, aged thirty-two years. Pain was referred for almost four years to the right upper quadrant of the anterior abdomen, coming on in various attacks, especially after exercise. Fourteen months before admission a stone was removed from the right kidney at Rio Janeiro. (The patient was shown the calculus.) Three weeks later he had another severe attack of renal colic, and on admission to the hospital the *x*-ray disclosed the presence of a calculus with a rough surface, which was readily removed from the kidney pelvis. The kidney was invested in dense adhesions.

Case VIII.—Female, aged twenty-nine years. Dull, aching pain terminating in the formation of a large hydronephrotic sac, which, when opened contained a small piece of gravel in the pelvis mouth. As the left ureter had not been found on cystoscopy no nephrectomy was done. Subsequently, the left ureter was catheterized and the left kidney found normal. A right nephrectomy was done, disclosing a large number of calculi in the old hydronephrotic sac.

Case IX.—Male, aged twenty-nine years. History of lumbar pain for the last twelve years with several attacks of sharp colic. During the eight months preceding admission to the hospital pain had become much worse.

Operation showed one calculus in the pelvis and a second one in the parenchyma. The former was removed through an incision in the pelvic wall, the latter by nephrotomy with suture of kidney tissue.

Case X.—Male, aged twenty-two years. History of ten years' pain of sudden paroxysmal character with no urinary

symptoms. A nephrectomy was done for multiple calculi with loss of kidney tissue. In addition, the patient suffered from pulmonary tuberculosis. The left kidney was normal. Satisfactory recovery.

Case XI.—Male, aged twenty years. History of pain in the right flank, radiating to the penis and the testis, of four months' duration. A stone was found in the kidney parenchyma a short distance above the pelvis, but not communicating with that cavity. It was removed through a vertical incision in the kidney tissue. Bimanual palpation failed to disclose other calculi. Six months later, an *x*-ray examination showed no stone in either kidney or in the pelvic ureter.

Three years after operation pain appeared in the right flank, radiating into the right testis. The patient frequently noticed the passage of thick white mucus in the urine. *X*-ray showed a large, dense shadow on the right side of the pelvis in the line of the ureter. Ten days later a large calculus was removed by the anterior extraperitoneal route from the right ureter near the pelvic brim. Six weeks later the patient required a right nephrectomy for a condition of pyonephrosis, no stone being found in the kidney.

Case XII.—Female, aged thirty years. Four years ago the patient first noticed pain on the right side, radiating first to the lumbar region and then to the mouth of the urethra. *X*-ray showed a number of calculi in the left kidney but none on the right side, the side of the pain. These were removed by both pyelotomy and nephrotomy from the pelvis and kidney parenchyma.

Six months after operation the patient still complained of pain on the right side. Both ureteral catheterization and *x*-ray proved negative.

Three years after operation the patient still complains of pain on the right side, coming on in attacks similar to those experienced before the calculi were removed. The patient

was confined to bed for a time without evident change in the character of the urine, the passage of which was noticeably increased during the day. Again *x*-ray examination was negative. The result of catheterization of the ureters was as follows: The urine from the right kidney was alkaline. It contained small numbers of both red and white blood cells. The amount passed during the time of observation was 2 cc. The urine from the left kidney was acid with the same cellular content as the right. The amount passed during the period of observation was 25 cc. The catheter passed easily up both ureters without sign of obstruction. The flow from the left was free and normally intermittent. That from the right was delayed and only appeared after the injection of saline solution. Neither urine was macroscopically abnormal. With the catheters *in situ*, an *x*-ray of the urinary tracts was negative.

Fifty-three months after operation there was no change in the subjective or objective symptoms.

Fifty-nine months after operation. For the past month the patient has suffered from attacks of pain on the right side, with chills and fever. An *x*-ray examination showed a large branched calculus in the pelvis of the left kidney with two adjacent smaller stones and one on the right side (the first appearance of a calculus in this kidney) somewhat smaller and irregular. During the following six months the patient passed several small calculi *per urethram*.

At present the patient is still under observation.

Case XIII.—Male, aged thirty-six years. No previous indication of renal calculus. On examination for life insurance a small amount of pus was discovered in the urine. This led to a cystoscopical examination in which the urine from the left ureter was found to be cloudy. *X*-ray examination then disclosed the shadow of a calculus the size of a lima bean in the parenchyma of the left kidney, which was successfully removed. The patient subsequently obtained life insurance.

Case XIV.—Male, aged forty years. Patient gives a history of occasional attacks of lumbar pain of short duration, becoming more frequent of late, extending forward and downward. Persistent tenderness in the lumbar region has followed these attacks of pain. During the attack the patient has noticed blood in the urine.

On operation a calculus was removed from the pelvis of the kidney through an incision in the posterior pelvic wall. Wound drained in the usual manner. Convalescence uninterrupted for eleven days, when without discoverable cause the patient developed a temperature of 104°. This continued without marked remission for four days, varying from 104° to 108°, when the patient died. There was no subjective or objective symptom in the abdomen or wound to account for this unusual clinical course. Unfortunately, no autopsy was permitted.

Case XV.—Male, aged fifty-nine years. Patient always well and strong. Recently, without warning, the patient noticed blood in the urine. This was repeated occasionally and in varying quantity for a fortnight. There was no pain or discomfort of any kind. The hematuria was the sole symptom. An *x*-ray of the kidney showed a small, concave, more or less pointed calculus. No operation, patient being kept under observation.

While renal calculus, with or without calculi in some other part of the urinary tract, is usually uncomplicated with lesions in other organs, the writer has observed one instance in which there existed a cholelithiasis, another in which a carcinoma of the stomach had been successfully removed, Case III, complicated by an intraligamentous cyst, while Case IV shows a tuberculosis of the affected kidney.

OSSIFICATION IN KIDNEY STONES ATTACHED TO THE RENAL PELVIS

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There exists a tendency to ossification in the organs of the urinary tract, under certain experimental and pathological conditions, which is greater than that in any other system of organs. Some of this ossification appears to be related to the direct and continuous action of the urine upon altered tissue bordering on the urinary channel. That in the kidney results from the fact that it is an end organ, and interference with its blood supply is followed by degeneration, which in certain animals, as the rabbit, creates a field for calcification and ossification that is more favorable than that produced in other organs. Experimentally, bone has been produced in ureter, bladder and kidney. Strauss[1] repaired defects in ureters in dogs with pedunculated flaps of fascia and found that in every instance a layer of bone formed in the portion bordering on the lumen, converting it into a rigid tube. Neuhof[2] repaired defects in the bladders of dogs by transplantation of fascia lata and found regularly that the portion of graft bordering on the lumen became ossified. Calcification was found to begin six days and ossification seventeen days after operation. There was no associated stone formation nor incrustation of bony plaques bordering on the urinary channel in either set of experiments. An epithelial lining grew from the margins and soon covered the entire bony surface, so that in the older experiments no bone bordered on the lumen. The pelvis of the kidney of the

mink[3] and of the coatimundi[4] is not infrequently invaded by the worm eustrongylus gigans, interfering with drainage and producing hydronephrosis with reduction of kidney substance. When these changes are marked, ossification occurs regularly in the thickened fibrous walls of the pelvis. Sacerdotti and Frattin[5] were the first to show that ligation of the renal artery in rabbits is followed by calcification and ossification in the necrotic kidney. Asami and Dock[6] ligated both renal artery and vein of the rabbit's kidney and found that bone formation began independently of calcification in the loose vascular connective tissue close under the transitional epithelium of the calyces. Bone later formed in the calcified area through erosion of the lime plaques and deposition of lamellæ by cells derived from fibroblasts.

In man, ossification in the urinary tract has been reported only in connection with the kidney and but rarely. However, calcification in the kidney is a common finding, especially in the pyramids, in acute destructive kidney lesions, as bichloride of mercury poisoning and in old age, osteomalacia, osteitis fibrosa and metastatic carcinoma of the bones, in which conditions there is mobilization of a considerable part of the stored-up calcium of the body. Localized calcification occurs in infarcts and degenerated inflammatory area, and there may be subsequent partial replacement of the lime salts by bone. Dr. E. R. Le Count has shown me sections of such an area near the cortex, the size of a pea, which was composed largely of bone. I have seen partial replacement by bone of calcified areas in tuberculosis of the kidney and in hypernephroma.

A search of the literature fails to show a recorded instance of ossification in connection with kidney stone, either in the pelvis of the kidney or within the stone itself. Also, there seems to be no record of stone attached to the pelvis of the kidney, either by a pedicle or as an incrustation on the pelvic wall. The three stones here to be described were attached to kidney lining and were composed partly of living bone.

CASE I.—J. M., male, aged thirty-six years, entered Presbyterian Hospital, September 28, 1921. He gave a history of attacks of pain and soreness in the left kidney region extending over a period of twenty-five years. Three months previously there was a severe attack of renal colic, and since then the urine

FIG. 1.—Case I. Roentgenogram showing circular area (*a*) of slight density in stone.

has been slightly cloudy at times. Blood was noticed first two days ago. Examination revealed slight tenderness in the left kidney region. A roentgenogram showed numerous stone shadows in the region of the left kidney (Fig. 1). There was a large, dense, branching shadow in the region of the pelvis. There

was a circular area of very faint density in the lower portion of this dense shadow, which comprised one-half of its diameter. The urine was acid in reaction and showed many pus cells and erythrocytes. On ureteral catheterization by Dr. Herbst, clear urine was obtained from the right kidney and cloudy urine, containing many pus cells and erythrocytes, from the left kidney. Cultures of the urine from both kidneys were negative. The reaction of the specimens of urine from the two kidneys was not determined separately. Left nephrectomy was performed by Dr. Bevan, October 3, 1921.

Pathological Examination. There was a small amount of perinephritis. On section of the kidney there was moderate dilatation of pelvis and calyces and reduction in height of pyramids. There were several small stones in the calyces, especially of the lower portion; and one large oval, branching, mulberry stone in the pelvis and extending into the upper calyx. Stone 1. Pelvic wall was ulcerated in places from contact with stone. The dimensions of the stone were 4.0 cm. by 2.5 cm. by 2.0 cm. After removal it was discovered that a fibrous pedicle ran into the stone at the fork. This had been broken before it was observed and its exact point of attachment in the pelvis was not located with certainty, but it was probably on the portion of pyramid that lay in the fork of the stone. The stone was broken open and found to be composed in its lower portion of a grayish nucleus comprising one-half of its diameter and extending to the surface at the point where the pedicle entered (Fig. 2). This portion had the appearance and consistency of spongy bone. The rest of the stone was composed of dense superimposed lamellæ, which were dark brown in its peripheral portion and grayish to light brown in its deeper portion, where it came in contact with the central nucleus. A roentgenogram of the reconstructed stone (Fig. 3) showed that the area of slight density corresponded to the nucleus resembling bone. Microscopical examination of a section from the nucleus showed it to be composed of living spongy bone containing marrow, fat, loose fibrous tissue and capillaries in its cancellous spaces (Fig. 4).

FIG. 2.—Case I. Drawing showing stone with pedicle and in cross-section with interior of bone.

FIG. 3.—Case I. *X*-ray of stone, showing lamination and area of slight density corresponding to bone.

A section of a decalcified portion at the line of junction of bone and stone showed, along one side of stone, a layer of crystals difficult to identify but apparently mostly calcium oxalate. They were invaded by connective tissue in which bony trabeculæ had formed (Fig. 5). Near the base of the pedicle, white fibrous tissue filled a considerable area of the nuclear space and on one side bordered directly on stone, which was made up of a layer of calcium phosphate crystals. Chemical analysis of a portion

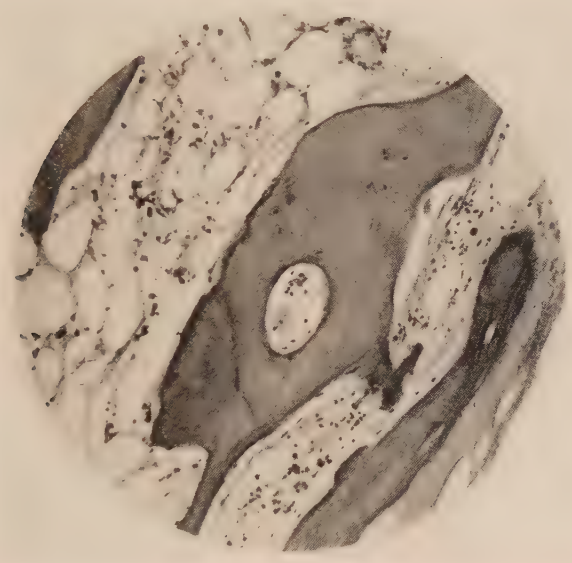

FIG. 4.—Case I. Photomicrograph of bone.

of the stone showed the inorganic elements to be composed of calcium oxalate 97 per cent and calcium carbonate 3 per cent. The inorganic elements comprised 96 per cent of the total dried calculus examined. There were traces of magnesium and phosphorus, but the murexide test for urates was negative. Apparently the periphery of the bone was in contact with an inner layer of stone, composed mostly of calcium oxalate in some portions and of calcium phosphate in others.

The order of development of the pathological picture presented cannot be definitely stated, but at the time of examination the stone was attached to the pelvis by a fibrous pedicle and its interior was composed of a large nucleus of bone, which, from microscopical examination at the line of junction, had been gradually replacing the stone. It is difficult to say whether the stone was attached from the beginning at a point of break in the

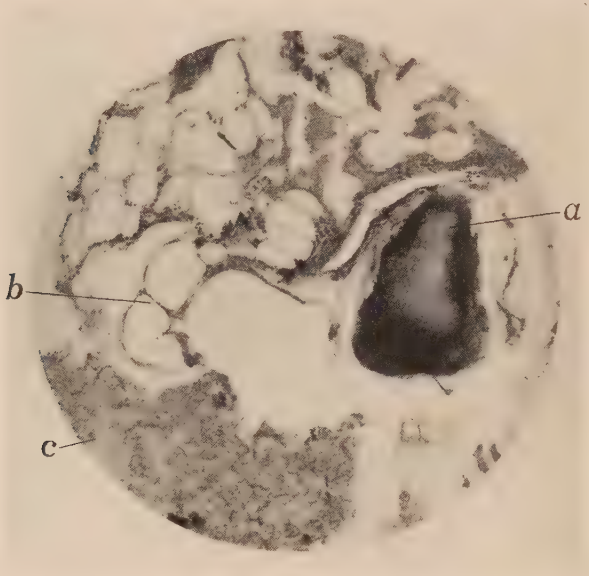

FIG. 5.—Case I. Photograph of junction of stone and bone: (*a*) is stone composed of crystals; (*b*) is invading capillaries and (*c*) is trabecula of newly formed bone.

mucous membrane of the renal pelvis and grew about the tip of a fibrous pedicle, which itself had already calcified and later gradually underwent metaplasia into bone. or whether the stone formed free in the renal pelvis and by its large size and roughened surface eroded the pelvic lining and became attached secondarily by an invading fibrous pedicle, the tip of which in turn ossified by metaplasia and replaced stone. The latter explanation seems

more probable, although the lamination of the stone about the bone is in favor of the early origin of the bone.

Case II.—J. P., male, aged twenty-four years, entered Presbyterian Hospital, January 15, 1923, giving a history of occasional

Fig. 6.—Case II. Roentgenogram showing stones but no discernible ossified areas.

attacks of pain in the right renal region during the past eleven years. During the past two months there had been increased frequency of and burning on urination. Physical examination was negative, aside from moderate tenderness and rigidity in

the right kidney region. A roentgenogram (Fig. 6) showed several shadows of stones in the right kidney. There was one large, dense, branching shadow in the region of the renal pelvis. No definite area of lessened density could be made out within it. The urine was alkaline and contained many pus cells, triple phosphates and amorphous urates, and catheterized specimens showed pus from the right kidney, but none from the left. Staphylococcus was grown in cultures of urine from the right kidney. The reaction of the urine obtained separately from the kidneys was not determined, but since the bladder was found normal and its urine alkaline, the urine from the right kidney must have been alkaline. Right nephrectomy was performed by Dr. Bevan, January 26, 1923.

Pathological Examination. There was some perinephritis and a slight cystic bulging of a portion of renal cortex opposite the pelvis. On section of the kidney, the pelvis was found to be slightly dilated and the calcyes markedly so. At the middle of the organ there was complete destruction of a lobule of kidney with a thin-walled sacculation of a calyx extending to the surface (Fig. 7). There were several small stones in the dilated calyces and a large branching one occupying most of the pelvis. Stone 2. Its middle portion was roughly granular and dark brown on one side, but the rest of its surface was smooth and sand colored. The lining of the pelvis was thickened and grayish-red in color. A small, short pedicle was observed to run from the side of the pelvis and to be attached to the middle portion of the stone at the margin of the dark surface. It was cut and the stone removed. It was then observed that pelvic lining coming in contact with the middle portion of the stone was lightly granular, and microscopical examination of an excised portion showed ulceration, round-cell infiltration and absence of epithelial covering. The pedicle of the stone sprang from this eroded surface.

A roentgenogram of the stone (Fig. 8) showed a superficially located area of slight density about the size of a wheat grain at the point of entrance of the pedicle. Suspecting that there might be bone filling out this area of slight density, I gouged

out its contents and had them sectioned after twelve hours of decalcification in 5 per cent nitric acid. Microscopical examination showed spongy bone with fibrous tissue, bone marrow and capillaries filling its cancellous spaces. Small portions of stone

FIG. 7.—Case II. Photograph of bisected kidney, showing large stone in pelvis attached by pedicle (*a*), and small mushroom-shaped stone (*b*) attached to wall of sacculation.

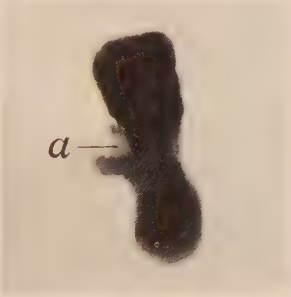

FIG. 8.—Case II. Roentgenogram of large stone, showing slight density at (*a*), corresponding to point at which bone was found.

were also present, some of which were attached to the bone, showing the undisturbed line of junction. The attached fragments appeared to be composed of oxalate, phosphate and carbonate of calcium. The stone was being absorbed by fibroblasts in a rich capillary network and directly replaced by bone (Fig. 9). The stone was then broken and its middle portion found to consist of a hard, dark brown, slightly laminated, irregularly spherical

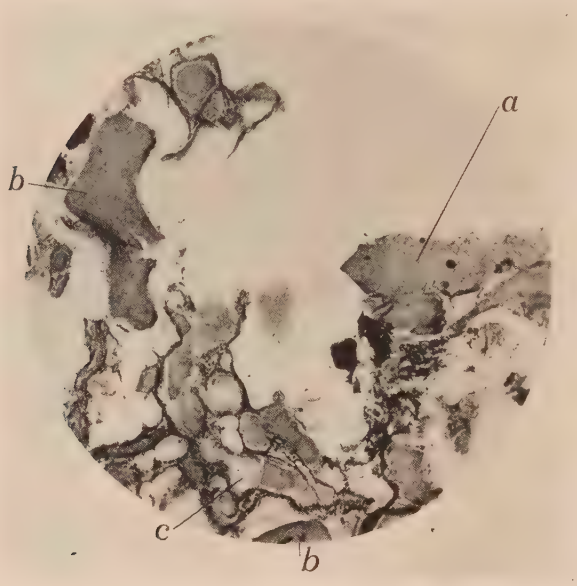

FIG. 9.—Case II. Large stone. Photograph at junction of stone and bone, showing calcified areas (*a*) being absorbed and replaced by bone (*b*). Capillaries numerous (*c*).

mass, which came to the surface on one side. Deposited on this was a sand colored, soft material which formed the two large, irregular poles. The pedicle had entered at a point where there was only a very thin sandy deposit on the dark central mass. The pocket occupied by bone was mainly in the peripheral part of the dark portion. The central nucleus of this area, which was the primary deposit, was some distance away from the bottom

of the pocket, so that the bone could scarcely be regarded as the nucleus or starting-point of the stone. Chemical analysis of the dark portion gave calcium phosphate, 10.17 per cent; calcium carbonate, 10.57 per cent and calcium oxalate, 79.26 per cent. The sand colored portion gave calcium phsophate, 86.35 per cent, calcium carbonate, 3.57 per cent and calcium oxalate, 10.08 per cent. Both portions contained traces of magnesium and gave a negative murexide test for uric acid.

This stone gave the appearance of having been invaded by the pedicle, which sprang from pelvic wall devoid of epithelial lining and had made a pocket in the periphery of the portion composed mainly of calcium oxalate. Bone had formed in the pocket as the stone was gradually absorbed.

On the inner wall of the sacculation in the cortex of the middle portion of the kidney, there was a flat mushroom-shaped stone about 1 cm. in diameter, attached by a short, broad pedicle. Stone 3. A section for microscopical examination was cut through the stone and pedicle, including 1 cm. of the wall of the saccule to either side. The pedicle consisted of a broad fibrous elevation of the wall and was capped by a layer of stone (Fig. 10). The line of junction of stone and bone was distinct. The stone was of a uniform light brown color and was not laminated. To facilitate decalcification, the stone was broken away, leaving only a thin, irregular layer attached to the pedicle. Microscopical examination of the section showed the wall of the saccule away from the pedicle to be composed almost entirely of fibrous tissue. The inner lining was formed by inflammatory tissue, consisting mainly of round cells with a few lymphocytes and plasma cells. There were no epithelial cells present. The pedicle was composed of mature connective tissue in its outer portion. Its inner portion consisted of connective tissue showing some degeneration, in which there was a heavy deposit of lime salts, which increased somewhat in amount as the junction with the stone was approached. The morphology of this deposit was similar to that of calcified areas found elsewhere in the body (Fig. 11). They have been found to consist of approximately

85 per cent of calcium phosphate and 15 per cent of calcium carbonate, and that is probably the composition of this deposit.

At the junction of pedicle and stone there are numerous small islands of bone, which have been laid down in the calcified areas.

FIG. 10.—Case II. Drawing of small mushroom stone.

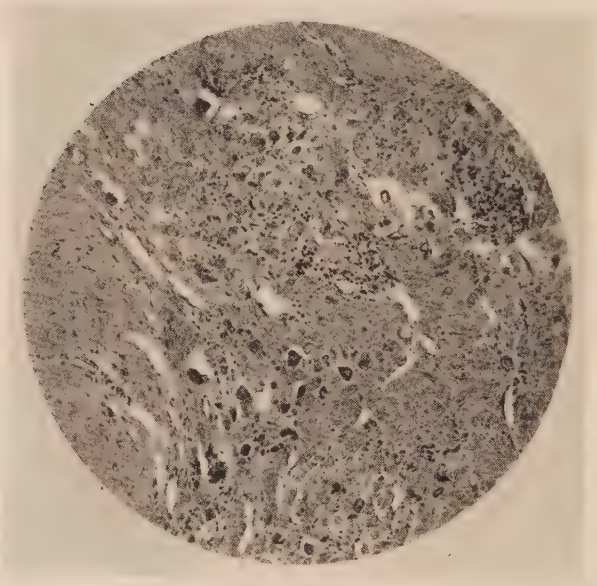

FIG. 11.—Case II. Photomicrograph. Calcification in pedicle of small stone.

This is quite similar to the ossification which is seen in calcified areas in other parts of the body. The attached portions of stone are seen under the high power to be composed of layers made up of a thread-like framework in which are deposited small granules and amorphous masses, which are lime salts, not easily identified, but presumed to be largely calcium phosphate and oxalate (Fig. 12). Chemical analysis showed the inorganic con-

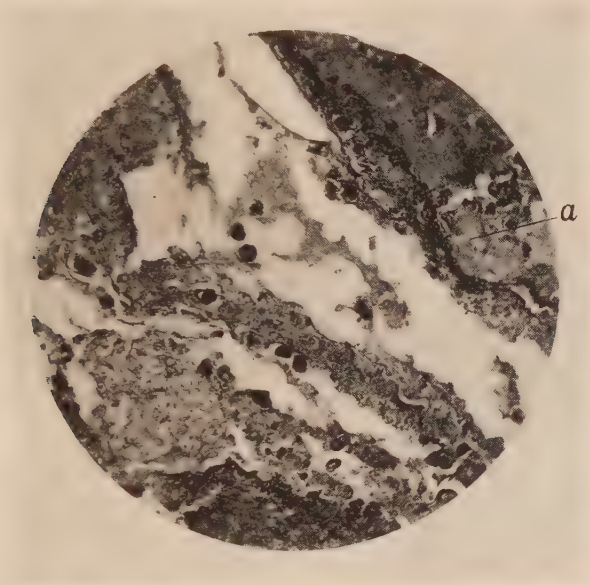

FIG. 12.—Case II. High-power of base of stone, showing framework and calcium deposits with invasion of bony trabeculæ (*a*).

stituents to be calcium phosphate 86.39 per cent and calcium oxalate 13.61 per cent. There was no calcium carbonate, and the murexide test for urates was negative.

This is the youngest stone of the three and shows the very beginning of the process of ossification in its pedicle. There is marked calcification in the pedicle, but all of the spicules of bone seem to have formed in the base of the stone, where connective tissue and blood-vessels have invaded it from the pedicle.

It seems probable in this case that calcification occurred first in the wall of the sac, which showed evidences of infection and was devoid of an epithelial lining. This was followed by the deposition of stone upon its free surface, and this in turn by ossification in the base of the stone.

There is a great deal of resemblance between bone, calcified areas and urinary stone. All three are composed of a crystalloidal substance or substances deposited in an organic and mainly colloidal framework. Bone consists of lime salts deposited in a definitely constructed living connective-tissue framework. The proportions of lime salts and framework remain constant, being about 60 and 40 per cent, respectively. Calcified areas consist of lime salts deposited in a framework of almost any degenerating or degenerated tissue of the body, and there is no definite relation between the amounts of each. The lime salts are the same in both calcification and ossification, consisting of calcium phosphate and calcium carbonate in the fairly constant proportions of 85 per cent for the former and 15 per cent for the latter. The composition of urinary stones is more variable in every respect than that of bone or calcified areas. Crystalloidal and colloidal deposits may be composed of one or more of a number of substances, any of which may vary greatly in amount. The crystalloidal deposits may be organic, as uric acid, urates, calcium oxalate, cystin or xanthin, or inorganic, comprising chiefly the carbonates and phosphates. Those comprising the three mixed stones in which ossification occurred were calcium oxalate, calcium phosphate and calcium carbonate. The framework of stones consists mainly of urochrome (held not to be a colloid by Lichtwitz[7] and others) nucleic acid and chondroitin sulphuric acid. The chemical nature of the framework in these stones was not determined. In view of this similarity in chemical composition it is not surprising that a field favorable for the occurrence of one of these processes should also be, at least to some degree, a favorable one for the occurrence of the others.

The question arises if there is a common factor in the urinary tract which influences the three processes, ossification, calci-

fication and stone formation. It is the general belief that both ossification and calcification occur normally in tissues that have an excess of acid present. The two stones here found to contain a considerable amount of bone were composed very largely of calcium oxalate, and oxalate stones form in acid urine. In the large stone of Case II, consisting of a primary oxalate portion and a secondary phosphate and carbonate portion, all of the bone was in the oxalate portion, suggesting that it began to form while the urine was acid. The secondary phosphate deposit was added after the urine became alkaline. Since the urine is mildly acid, due to the presence of acid sodium phosphate, and bathes the field along the urinary channel in which these processes start, it should be considered as a possible causative factor.

Strauss attributed the ossification in fascial flaps, used to reconstruct the ureter in dogs, to the direct action of the acid urine upon the fascia. Neuhof considered the calcification and subsequent ossification in the fascial transplant into the dog's bladder to be in the nature of a functional response to strengthen the weakened portion of wall. He thought the lime salts came from the urine and were deposited in the degenerating fascia. Their presence in turn stimulated the surviving elements of the graft to change into bone, which is the most powerful barrier. Dr. Howard Dabbs and I repeated Neuhof's experiments on dogs and verified his findings, but we have interpreted the calcification and ossification differently. Dogs' urine is acid. The rabbit, which has alkaline urine, was used by us in four experiments, and the animals were killed in from ten to forty days. Calcification and ossification failed to occur in any of them. The sheep, which also has alkaline urine, was used in a seven weeks' experiment, and bone failed to form. We attempted to keep the urine continuously alkaline in a number of dogs with fascial transplantation into the bladder, by means of diet and administration of alkalies, but found it impossible of achievement. Bone formed in the transplant in every experiment, despite the fact that the urine was alkaline for certain

periods of each day. These observations support the view that the acid reaction of the urine has something to do with the bone formation. As previously stated, all calcified areas have been found to contain about 85 per cent of calcium phosphate and 15 per cent of calcium carbonate, which represents their relative solubility in the blood, and precipitation of salts from a solvent occurs according to their relative solubility. The salts are carried in the blood mainly in colloidal solution and they are found in the urine in a different proportion than in the blood, the calcium carbonate being relatively much lower. Therefore it seems logical to assume that the lime salts are deposited from the lymph or blood in the portion of transplant bordering on the lumen, where nutritional conditions are poorest, necrosis is greatest, and acidity increased by contact with the acid urine of the bladder. Ossification follows as a sequence to the calcification, and is also augmented by the urine.

The findings in stones 1 and 2 suggest the following pathogenesis: Oxalate stone 1 and the primary oxalate portion of stone 2 formed in acid urine. They grew to a size where they became fixed in the pelvis. Their roughly granular surfaces produced pressure erosion of pelvic epithelial lining. Connective tissue grew out and invaded a pocket of the stone. The lime salts of the stone and the acid reaction of the urine with which the invading pedicle came in contact produced metaplasia into bone with resultant osseous metamorphosis in the calculus. No calcification was seen in the invading connective tissue of these stones. After infection and alkalinization of the pelvic urine in Case II there was secondary stone formation, consisting mainly of calcium phosphate. No experiments have been reported on the implantation of calcium oxalate in the tissues to determine whether or not it is gradually replaced by bone, but those of Wells,[8] in which a variety of calcium and other salts were used, gave uniformly negative results.

The findings in stone 3 suggest a different process of development and to some extent contradict that given for the first two. The sacculation apparently occurred first, and calcification took

place in a portion of the wall devoid of epithelium. Lime salts from the urine were then deposited on it in the nature of an incrustation, such as is seen upon a non-absorbable suture or other foreign body projecting into the urinary tract. A small amount of ossification took place in the base of the stone, where it joined the partially calcified pedicle.

The failure in the past to recognize cases of living bone in kidney stones has probably been due mainly to two facts. The pedicle entering the stone is short and frail and easily broken or overlooked during removal. Also the area of bone may be small and escape detection on section, or, if large, it may be regarded as a separate calcareous deposit in a mixed stone. In the roentgenogram of stone 1, the area of slight density corresponding to the cancellous bone is similar to that produced by a primary uric acid or urate stone with a secondary calcareous deposit about it and the bony shadow might easily be interpreted as due to urates.

I am indebted to Miss Mary E. Mavee, of the Sprague Laboratory, University of Chicago, for the chemical analyses of the stones.

Literature

1. Strauss, Alfred A.: An Artificial Ureter Made from the Abdominal Wall, Surg., Gynec. and Obst., 1914, xviii, 78.

2. Neuhof, Harold: Fascia Transplantation into Visceral Defects, Surg., Gynec. and Obst., 1917, xxiv, 383.

3. Weinland: Arch. f. Naturgeschichte, 1859, i, 283.

4. Leuckart: Die Parasiten des Menschen, ii, 396.

5. Sacerdotti and Frattin: Arch. f. path. Anat., 1902, clxviii, 431.

6. Asami, G., and Dock, W.: Experimental Studies on Heteroplastic Bone Formation, Jour. Exper. Med., 1920, xxxii, 745.

7. Lichtwitz: Deutsch. med. Wchnschr., 1910, xxxvi (i), 704.

8. Wells, H. Gideon: Arch. Int. Med., 1911, vii, 721.

DISCUSSION ON THE PAPERS OF DRS. DEAVER, GAGE, GIBBON, LOWER, ELIOT, JR., AND PHEMISTER

Dr. F. B. Lund, Boston:

In regard to Dr. Gibbon's paper on technic, he did not say anything about cystic kidney. I believe that large single cysts need to be excised, and I believe that there are cases of congenital cystic kidney which are much benefited by the reduction in size of the tumor by Rovsing's operation of puncture of the cysts.

It requires a good deal of judgment to do the right thing, because the intervening kidney tissue is destroyed by the cysts and there is always an interstitial nephritis.

I have had 1 case, a woman, who is still living, fourteen years after the removal of a congenital cystic kidney, and each time she became pregnant she developed symptoms of uremia until I tied off the tubes. Since the operation she has been doing her own housework. I had also a second case in which I cut down upon and punctured the cysts in a young woman who was leading an active life as a nurse eight years after the operation.

Since reporting the 2 above cases, I have had 1 case in which I did Rovsing's operation on both sides, but the patient died of apoplexy six months later. Such an accident might have happened immediately after the operation just as well as not.

I feel that each case has to be decided upon its own merits. I know there are cases which are greatly benefited by this operation, and I shall not hesitate to do it when I get the opportunity.

Dr. Albert J. Ochsner, Chicago:

I want to direct attention again to the systematic use of large quantities of distilled water for the prevention of recurrence of calculi. In a large number of cases of removal of calculi I have observed recurrence only in those cases in which large quantities of distilled water was either not taken or not taken systematically, that is, if the patient takes a large quantity of distilled water for a few weeks or months and then stops taking distilled water, or if he drinks other water, which contains much lime, recurrence is apt to follow. This is based upon two facts that everyone knows: (1) That there are certain regions in which stones occur frequently. That is in the region in which there are large quantities of lime in the water, for instance in India. Observations have been made that the wheat-eaters have renal calculi and the rice-eaters have no stones. Wheat grows only successfully in countries in which lime is in abundance,

and rice grows where lime is not in abundance. We also know that in countries in which the red wine abounds there is an abundance of calculi. In countries in which it is not abundant you have not the calculi.

Nearly forty years ago, Harrison Cripps, of Liverpool, later of London, demonstrated in a large number of cases that calculi occur only in cases in which there is a certain concentration of urine. If you give large quantities of distilled water systematically the urine will not reach that degree of concentration.

It has been claimed that certain foods contain large amounts of lime; for instance, milk contains a considerable amount of lime. Everyone knows that there is a tremendous difference between the lime in water and the lime in food. A simple illustration can be found in the fact that lime collects from water in a new tea-kettle almost immediately, while milk can be cooked in a new vessel indefinitely without causing the deposit of any lime.

Dr. Charles H. Mayo, Rochester:

In this interesting discussion of diseases of the kidney I wish to confine my remarks to stone in the kidney. It is well known that stones form slowly in the cortex and more rapidly in the pelvis, the calcium of various types being taken from the fluids as microbic life can get it. Stones in the cortex grow slowly, like pearls in mollusks, which are also built by microbic life just as the shells of the mollusks are built by the same workmen. In working with a considerable number of dogs an alveolar focus of infection was developed by grinding their bicuspid teeth under an anesthetic, extracting the root pulp by dental exposure and filling the cavity with bacteria which had been sedimented from the urine of patients with stone in the kidney. Sealing was then made with amalgam or white cement. It was found that 66 per cent of them developed free stones in the pelvis of the kidney within a few months, and 86 per cent free stones or heavy calcium deposit in the medulla of the kidney within a few months after the development of the focus.

Stones in the kidney do recur to a considerable extent, and we have not done our whole duty by these patients unless we pay more attention to the examination of teeth and tonsils and the removal of foci of infection in them which, if neglected, may lead to a reformation of stones in the kidney.

Dr. Willy Meyer, New York:

In case of a combination of stone in the renal pelvis and of the ureter, it seems best and safest for the patient to do a two-stage

operation, namely, to remove the stone from the ureter first and in the second stage remove the stone from the pelvis or parenchyma of the kidney. This is imperative if there is renal infection. After the infection above has been taken care of, remove the stone in the ureter. I would briefly cite a most interesting observation in this respect: There was severe infection of the kidney with repeated chills and high fever. On exposing the organ the cortex appeared to be riddled with miliary abscesses which contained the colon bacillus in pure culture. By splitting and draining the kidney first this serious infection was overcome, and the stone could later be successfully removed from the ureter.

Personally, I like to suture the incised wound of the ureter without grasping the mucosa. I introduce a short cigarette drain, the lower end of which is at least one inch away from the ureter.

With reference to going down upon the kidney, I have practised the posterior incision for more than thirty-five years. I realize that now and then we are obliged to resect the twelfth rib in that way. If the patient rests on the abdomen, flat on the operating table and not on the raised cross-bar, the wounding of the pleura can with a little care usually be avoided. Should it happen anyway the abdominal posture guards against the danger of lung collapse. Of course, there is some collapse, by the influence of which the lower border of the inferior pulmonary lobe moves up to some extent. But this is welcome, as it enables the surgeon to stitch the parietal pleura with overlying endothoracic fascia and periosteum to the diaphragm and pleural cover by a continuous suture of catgut. No harm has ever been seen to come from such an accident.

The scar resulting from this posterior renal approach is never tender nor does it tend to the formation of a hernia, while the scar following the incision from the twelfth rib downward with transverse division of the abdominal muscles sometimes remains painful for many years. The posterior incision can also be nicely done under local and regional anesthesia, which is of importance, for instance, for resection of the capsule in chronic nephritis or in Rovsing's operation for congenital cystic kidney. A surgeon who operates on the kidney should best master every kind of useful incision and select in advance according to indication and local conditions.

Dr. George E. Brewer, New York:

I do not agree with Dr. Gibbon that it is always safer and easier to remove a large stone by a combined pyelotomy and nephrotomy than do a nephrectomy. I am certain that there are certain types of cases where it would be impossible to remove a large branching

stone without tremendous damage to the kidney. I have had 2 such cases in which there was very great hemorrhage, and there is always a certain amount of risk. If the kidney pelvis is filled with this type of calculus I do not see how you can make an incision through the pelvis and get the stone out without very great damage.

I agree with him in the main, but I feel that there are certain types in which I do not think we ought to hesitate to do a nephrectomy.

With reference to Dr. Lower's paper, in which he speaks of the type of hematogenous nephritis, where he rarely does a nephrectomy, I think that depends on the type, and that there is a type in which a nephrectomy is the only thing to do to save the patient's life.

When I brought this subject before this society, years ago, I had 5 patients of this type in which there was no operation and all the patients died. Fourteen other cases in which I did a nephrectomy all got well. It is not the ordinary type; it is the hyperacute type.

With the type that begins with a chill and high temperature and is followed by progressive toxemia, I believe that nephrectomy is the only thing that will save life.

One other point: I was very much interested in the fatal case of Dr. Eliot. I had exactly a similar case two years ago, and it was the easiest operation I ever did. I cut right down upon the stone and sewed up the pelvic incision. Symptoms of toxemia developed on the third day, followed by a rapidly rising temperature, and death ensued on the fourth day. I had no idea as to the cause of death. The peritoneum had not been opened. On autopsy there was a hemolytic streptococcus peritonitis. We could not find a point of leaking anywhere. There was a good deal of edema of the surrounding areolar tissues.

Dr. Howard Lilienthal, New York:

I merely wish to report a case of carcinoma of the bladder, squamous-cell variety, now well more than eleven years after the operation. The tumor was about the size of a 5-cent piece and surrounded the right ureter. I had located it with the cystoscope. I did a suprapubic cystotomy and removed the tumor with a portion of the ureter. Later the patient's right kidney became infected and had to be removed. The man is perfectly well today.

One other case that I had was a man who had a kidney stone which I could not locate in the cortex. I left the wound open. When the man became conscious he was able to direct my efforts in the right direction by his sense of pain on manipulation, and the stone was found and successfully removed.

Dr. M. L. Harris, Chicago:

In regard to the point brought out by Dr. Lower, on the desirability of operating on the more extensively involved kidney in the presence of bilateral tuberculosis, I may say that I presented a paper on that subject some years ago and at that time advised the removal of the more extensively involved kidney when it seemed probable from tests made that the lesser involved kidney still retained sufficient functional efficiency. I now have cases living from fifteen to twenty years after the removal of one tuberculous kidney when the other kidney was known to be tuberculous. These patients are perfectly well at this time.

Fifteen years ago I presented a paper on "The Bacterial Origin of Renal Calculi" and showed that the nuclei of these stones consisted of clumps of bacteria about which crystallization took place.

Dr. John E. Summers, Omaha:

Several months ago I had occasion to remove a large hydronephrotic kidney which I did not think could be removed through the usual oblique lumbar incision. Having been familiar with the incision which Dr. Louis Bazy (Paris) advocated and published ten years ago, I adopted that incision. It consists in commencing about opposite the end of the eleventh rib and a little below and behind, and carrying the incision transversely across the abdomen midway between the umbilicus and ensiform cartilage. This brings you directly down to the pedicle of the kidney. You can free the peritoneal pouch forward and have space to remove a large kidney which you could not otherwise remove. I believe this is a safer and easier procedure for the removal of large tumors of the kidney which cannot, except with great difficulty, be removed through the iliocostal space. I carried it out once very successfully; it is the only experience I have had with the incision.

Bazy reported to the Paris Surgical Society, last December, 43 interventions upon the kidney, including operations for carcinoma, tuberculosis, etc., in which this technic was successfully carried out by himself; he also reported a number of similar cases operated upon successfully by colleagues using the same technic. I have only had the one experience, but I can recommend the incision, as I do not believe I could have removed the kidney in any other way.

Dr. L. W. Hotchkiss, Santa Barbara:

I would like to report one case of infiltrating carcinoma near the base of the bladder in a man of twenty-three years, treated

by the radical operation and which has survived for eight years. He has been subjected to repeated examinations with the cystoscope and shows no recurrence, which in view of his youth and the character of the growth removed seems rather remarkable.

Dr. Lincoln Davis, Boston:

I wish to report a case of an infiltrating carcinoma of the bladder in which I did a radical operation over eight years ago. He recently returned with hematuria and a cystoscopic examination showed that the blood was coming from the left ureter. The bladder was normal and there was no sign of a recurrence there. He had some pain in the region of the left kidney. The kidney was explored and found to be markedly dilated and the pelvis very tense and full of blood. The kidney was removed with a portion of the ureter. Exploration with the finger down the course of the ureter did not reveal anything very definite other than some thickening. It was impossible to pass a ureteral catheter up the left ureter.

When the specimen was examined it was found to be a hemonephrosis. There was no tumor of the kidney itself nor other cause of bleeding in the kidney. When the patient was returned to the ward after operation he still had hematuria, which continued the same as before the nephrectomy. The cystoscope showed that the bleeding was still from the left ureter. Catheterization of the other side revealed normal urine. He consented to another operation and I went into the peritoneal cavity and found that there was a hard, flat mass along the left wall of the pelvis to which the ureter was attached. I removed a small specimen, but it was too small for a satisfactory pathological examination; it was reported as an osteosarcoma. The patient died four months later. There was no postmortem. I have never reported the case because I felt that there was some doubt as to the nature of the recurrent tumor. It is my belief that it was probably a recurrence of the original carcinoma of the bladder in the wall of the pelvis. The interesting point is that this tumor invaded the ureter from the outside and produced the hematuria.

Dr. Gibbon (in closing):

Dr. Finney's remarks on the primary isolation and ligation of the renal vessels through an abdominal incision are appealing, but I cannot see why the kidney should not then be removed through the same incision.

I cannot agree altogether with Dr. Brewer, because the type of case in which he suggests nephrectomy is very apt to be that in which

there are stones in both kidneys or in which stones are likely to form in the remaining kidney.

As to the large branching stones: If the incision is enlarged I think they can be removed and the kidney preserved, which is the safest plan. The only justification for nephrectomy in the case of stone is the complete destruction of the kidney by infection or its hopeless injury.

In the case of soft phosphatic stones the kidney should be irrigated so as to wash out small fragments. In many of these cases I believe that we can avoid doing a nephrectomy.

Dr. Lower (in closing):

It was not intended in this presentation to discuss the technic of operations for all lesions of the kidney, but rather to give some of the principles which govern these types of operation. In bilateral cystic kidneys, of which Dr. Lund speaks, I think patients are made more comfortable by puncturing cysts of the kidney, especially when the kidneys are very large and tense. I am convinced that in some of these bilateral infections of the kidneys it is advisable to wait. In several instances in which I deferred operation because of the severity of the case, later developments proved the operation unnecessary. For carbuncles of the kidney I think immediate surgical intervention the best form of treatment. The technic referred to by Dr. Finney is no doubt admirable. I never hesitate to make the incision as large as may seem desirable, for I think it is a mistake to try to perform these operations through too small an incision, and thus far, if no infection has been present, I have never seen a hernia develop.

Dr. Eliot (in closing):

Dr. Finney's suggestion in regard to the treatment of tumors of the kidney is, I believe, valuable for the reason that the abdominal route facilitates the control of hemorrhage, an advantage not to be overlooked, as some of those growths, as well as the investing perirenal tissues, are decidedly vascular. Furthermore, it is easier, through an abdominal rather than a lumbar incision, to determine the operability of a tumor of the kidney, for involvement of the adjacent colon, liver or other viscus, as well as abdominal metastases, is more readily recognized.

As to recurrence of renal calculi, I am very glad that Dr. Ochsner has had more success in the West than we have had in the East. The exhibition of distilled water is most desirable, especially in the

Middle West, where the water is so generally hard. In New York and vicinity the water is excellent and scarcely to be improved by distillation. On the other hand, it is frequently very difficult to get patients to carry out careful instructions. In one case reported in this paper the patient was constantly warned of the possibility of recurrence for a period of at least four years, and the importance of drinking large quantities of water and observing suitable dietetic precautions were duly emphasized, yet at the end of that time recurrence had developed in both kidneys.

I agree with Dr. Gibbon in the desirability of drainage after removal of calculi from the kidney pelvis or ureter. If this precaution is taken there seems to be no contraindication to the exposure of the calculus in the ureter through an incision in the overlying posterior parietal peritoneum and its subsequent suture. I have never seen this procedure, which frequently shortens the operation, followed by any local reaction.

Occasionally, in the male, a calculus is impacted in the lowest part of the ureter, a position from which its removal by direct attack is both difficult and dangerous. Under these circumstances the calculus may be pushed upward and delivered through an incision in the accessible part of the pelvic ureter, or, after crushing, pushed downward through the same incision into the bladder. In either manipulation the finger of the surgeon in the peritoneal cavity is a valuable adjuvant.

TREATMENT OF HOUR-GLASS STOMACH BY DOUBLE GASTROENTEROSTOMY

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The object of this paper is to call attention to the value of a procedure which I think should be more often employed. Devised theoretically by von Hacker and Weir and Foote,[1] it seems to be performed infrequently and is mentioned with apparent reluctance by the writers on hour-glass stomach.

While I can cite only 2 cases, the results, immediate and remote, gave the maximum satisfaction to patients and operator.

Case I.[2]—M. D., aged forty-two years; housewife. Admitted February 5, 1917, on account of epigastric pain, vomiting and loss of weight. In 1915, she weighed 121 pounds; now weighs about 80 pounds.

Present Illness. Began two and a half years before admission with epigastric pain accompanied by gaseous eructations, occurring about three hours after the noon-day meal and continuing until about 11 P.M. Symptoms gradually increased in severity. Pain relieved by vomiting and by taking sodium bicarbonate until about one year before admission, when these measures ceased to give relief. No hematemesis or melena. Patient has recently noticed splashing in stomach and peristaltic movements in upper abdomen.

[1] Med. News, April, 1896.

[2] Previously reported by Webb, Ann. of Surgery, October, 1917.

Physical Examination. There is a bulging, tympanitic area in the upper half of the abdomen corresponding to the position of a dilated stomach. Here peristaltic movements can be seen traveling from left to right and ending under the right costal border. Clapotage present. There is a palpable, movable mass about the size of a lemon just above and to the right of the umbilicus. Wassermann negative.

Operation. There is a huge stomach, the pyloric pouch being three times the size of the cardiac pouch. The constriction between the two pouches is due to cicatrization of a large ulcer which forms a tumor nearly the size of a hand. The pylorus is obstructed by a similar large, callous apparently cicatrized ulcer. A small node lying on the pylorus excised. Microscopical report normal. Double posterior gastroenterostomy is done: one in the cardiac pouch, without clamps, using five rows of sutures (three posteriorly and two anteriorly), using silk for the first and last and fine chromic gut for the other three. The same loop of intestine is used five inches away for a second gastroenterostomy in the middle of the pyloric pouch.

Subsequent Course. Recovery uneventful. Sixth day, taking soft, solid diet; tenth day, sat up in a chair. Discharged, March 5, 1917, free from symptoms.

Follow-up (May 7, 1917). Free from symptoms. Has gained 32 pounds. Barium series shows stomach empties rapidly, being nearly empty at the end of one hour and practically free from barium at the end of five hours. Both gastroenterostomy openings are working well (Figs. 1 to 5).

Subsequent Notes. January 30, 1919: Gained enormously in weight.

May 1, 1922: Feels O. K.

June 15, 1923: Recently had a mild gastric upset which the patient attributes to disturbance of the menopause. Weight, the same.

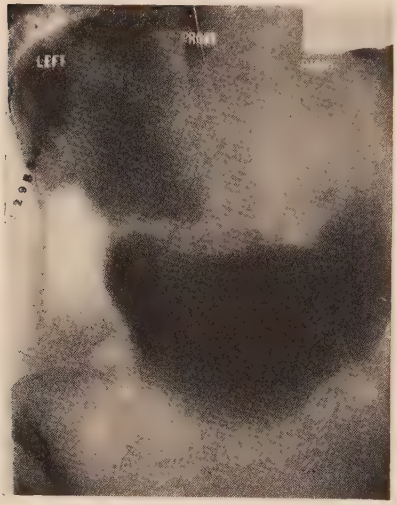

FIG. 1

FIG. 2

FIG. 3

FIG. 4

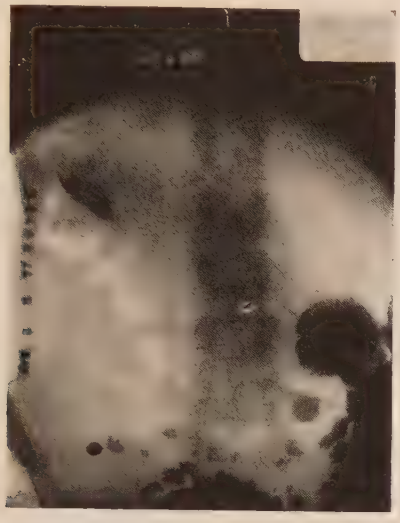

FIG. 5

FIGS. 1, 2, 3, 4 and 5.—Reproduction of *x*-ray plates of cases of hour glass stomach before and after operation (Case I). Published in Annals of Surgery, October, 1917 (Roscoe C. Webb: Operative Treatment of Hour-glass Stomach.)

CASE II.—M. L., female, aged fifty-four years.

Present Illness. Gastric manifestations since the age of eighteen, at which time had attacks of pain with distention. These attacks come on three or four hours after meals and the patient has been in the habit of reducing pain by inducing vomiting.

Physical Examination. Fairly well nourished. Abdomen shows distinct visible peristalsis over its lower part. Wassermann, negative. Hemoglobin, 88 per cent.

Fluoroscopical Examination (by Dr. A. L. Holland). Large hour-glass stomach, cardiac pouch a little the larger. The upper pouch empties fairly quickly. The pyloric pouch shows a marked retention at the end of thirty hours. There is also a pyloric ulcer with marked obstruction (Fig. 6).

Operation (April 26, 1922). Stomach very large and divided into two pouches. Opening between the two is about the caliber

of the small intestine. The pyloric pouch is drawn out into the duodenum, both being of distinctly smaller caliber, appar-

FIG. 6.—Print of *x*-ray plate of hour-glass stomach before operation. (Case II.)

ently from distortion, as there is no constriction. There is also a Harris band, which is separated, and some adhesions of the

duodenum to the liver. The cardiac pouch is altered; the structure seems to be for the most part thick, somewhat indur-

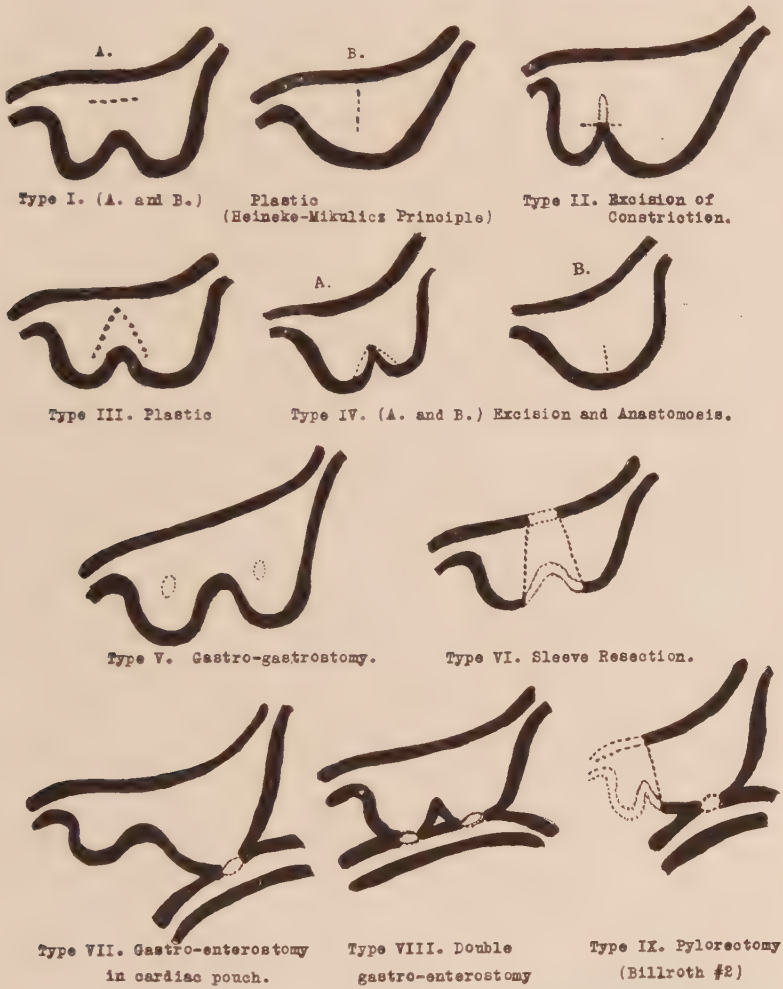

FIG. 7.—Original drawing of "Types of Operation for Hour-glass Stomach."

ated and of whitish appearance. Two gastroenterostomies are done in the same loop of intestine. Openings are made about

2 inches and 7 inches from the fossa of Treitz, as in Case I. Time, one hour and twenty minutes.

Convalescence. Most uneventful. Highest temperature, 100°. Never vomited. Discharged May 17, eating quite substantial diet. Entirely free from any gastric disturbance.

Follow-up. September 27, 1922: In excellent health and reports herself free from any gastric symptoms ever since operation. Gained 25 pounds.

June 14, 1923: "Have been well all winter and able to eat as I never have before."

It is difficult to understand why so simple and logical an operation as double gastroenterostomy is so seldom employed. It seems particularly called for when, as so often happens, an additional juxta pyloric ulceration causes an actual or potential obstruction. The possibility of overlooking this pyloric stenosis should render us very cautious in confining ourselves to some of the plastic operations (Fig. 7, Types I, II and III) or the anastomosis of the pouches with each other (Fig. 7, Types IV and V). If we do not perform any plastic operations or some form of gastroenterostomy there remains then some type of resection (Fig. 7, Types VI and IX). In general, it may be stated that resection in the hour-glass stomach is to be avoided if the condition can be adequately dealt with otherwise, for the following reasons:

1. The hour-glass stomach is the end-result of a long-standing, particularly severe gastric ulceration, and most of the patients are greatly debilitated and poor risks.

2. Any form of resection has a definite risk of being followed by any of the varieties of pneumonia.

3. Gastroenterostomy may very often be performed with great ease under local anesthesia, particularly if the abdominal wall is thin and lax and the stomach is large or ptosed, as it generally is in emaciated patients.

4. Other operations of less severity give good results.

I have never seen any unfavorable reports following the performance of double gastroenterostomy. It is possible that

to many operators the term "double gastroenterostomy" means some much more complex procedure than the one used by me (Fig. 7, Type VIII), namely, typical no-loop posterior anastomosis in the same loop of the jejunum, the second opening being made wherever the second pouch can be conveniently drawn through a separate opening in the transverse mesocolon, 3 inches to 6 inches from the first.

To some the procedure may seem illogical—that the outflow from the first gastroenterostomy may enter the stomach through the second opening. Admitting, for the sake of argument, that such a reflux takes place, does it do any harm? Certainly the uneventful convalescence of the cases reported, with their splendid after-results, controvert any theoretical objection. Moreover, if there is any validity to the belief that an alkaline dilution of the acid gastric contents favorably influences or prevents ulceration, the lower pouch and pyloric outlet cannot but be benefited by the intestinal reflux.

In the United States there seems to be a tendency to employ more and more the sleeve (mesogastric) resection. The principal advantage claimed is the removal of a cancer which may simulate the typical hour-glass deformity or as a prophylaxis of its development. It seems to me that the possible cure of such a cancer must be doubtful. The margin of the resected area is not usually sufficiently wide and the area of the lymphatic drainage toward the pyloric end persists. Some operators have abandoned sleeve resection because an artificial hour-glass has resulted from the narrowing of the anastomosis.

The indications for resection are lessened if we remember that constriction represents the healing of an ulceration. The process itself is usually extinct and only its mechanical aftermath has to be considered.

If the lower pouch is very small, and particularly if the hour-glass constriction is very tight, a single gastroenterostomy in the upper pouch may suffice in the absence of a pronounced pyloric stenosis (Fig. 7, Type VII). In such a condition any form of gastroenterostomy—posterior, anterior or anterior

retrocolic—in the lower pouch might be difficult or functionally imperfect. In such a case posterior gastroenterostomy in the large upper pouch may be expected to work well. For instance, one of my patients had a large, visible and palpable tumor of the pyloric end of the stomach. Operation showed a large, irregular mass, presenting every appearance of a carcinoma, causing hour-glass deformity with an extremely small second pouch. A posterior gastroenterostomy in the upper pouch resulted in a good convalescence and subsequent disappearance of the mass.

In conditions such as described, if absolute necessity existed for dealing with a small second pouch, a pylorectomy would probably be best performed. I should feel, however, that in poor risks the operation might be done in two stages, placing the gastroenterostomy so as to allow eventually of resection.

T. T. Thomas[1] has made one of the most interesting and valuable contributions to the treatment of hour-glass stomach. Some of his observations markedly confirm the complexity of the condition and give valuable hints. In his 50 cases the following procedures were used:

1. Gastroplasty, 7.
2. Gastrogastrostomy, 15.
3. Posterior gastroenterostomy in the proximal pouch, 14.
4. Double posterior gastroenterostomy, 2.
5. Retrocolic anterior gastroenterostomy, 3.
6. Anterior gastroenterostomy, 3.
7. Gastroduodenostomy in proximal pouch, 1.
8. Retrocolic anterior gastroenterostomy in proximal and posterior gastroenterostomy in distal, 1.
9. Partial gastrectomy, 2.

The mortality is 14 per cent. The end-results by any method were good, showing wise judgment in applying the method best suited to any given condition. It is interesting to note that a resection was performed only twice; still more so, the success

[1] British Journal of Surgery, vol. ix.

FIG. 8.—Print of *x*-ray plate of trifid hour-glass stomach.

attending the plastic operations and anastomoses. Personally, I have had rather a prejudice against these latter operations, having had some poor results while other forms of treatment have been successful.

Thomas says, "There is no condition in surgery that may call for so great a variety of procedures to deal with the degrees and complications met with; and although the radiographic evidence affords valuable help, it is impossible in any given case to have the slightest idea beforehand what surgical maneuver will be resorted to."

The accuracy of the above statement was illustrated in a case of trifid stomach (Fig. 8) occurring early in my experience. The reproduced *x*-ray picture was outlined by the roentgenologist only after the postmortem had demonstrated the complexity of the condition.

In conclusion, I would call attention to the hint furnished by the size of the lower pouch as regards the presence of a second obstruction at the pylorus, and it is in these cases where the stomach is divided into pouches of different sizes, or the lower pouch is distinctly large, that the operation of double posterior gastroenterostomy is particularly indicated.

A FUNDAMENTAL FACTOR IN THE RECURRENCE OF INGUINAL HERNIA

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AND

KEHAR SINGH CHOUKE, M.D.

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(By Invitation.)

The modern operation for the repair of inguinal hernia may be said fairly to date from 1889 and 1890, when Halsted and Bassini published their studies. It may also be said, with assurance, that the thirty odd years' experience gained from the performance and study of this operation has taught us that the fundamental principles underlying the permanent operative cure of hernia are as follows: (1) High ligation of the sac; (2) adequate reinforcement of the defective abdominal wall, and (3) primary wound-healing.

No one of these three requirements is particularly elusive nor does any one of them seem difficult of accomplishment. Yet the percentile figures of postoperative recurrence are very far from being encouraging. Unfortunately there exists a most disconcerting divergence of opinion regarding the frequency of recurrence, a divergence ranging all the way from eight-tenth of 1 per cent to 12 per cent, both sets of figures coming from surgeons of enviable reputation. One cannot help feeling that the higher percentile rate is, of the two, the more entitled to credence. Inquiries regarding postoperative recurrences are usually made by letter and the patient's replies are credited at their face value, in spite of the fact that the patient himself is a most untrustworthy judge of early though definite recurrence.

Our recent experience with draft men demonstrated the incredibly large percentage of hernias that existed without any knowledge of their existence on the part of men affected.

Even more convincing to us than figures covering the frequency of recurrence is the almost incalculably large number of modifications of the Bassini operation that have been devised and described. It may be said of surgery as of medicine, that a multiplicity of remedies for any one disease indicates, almost beyond doubt, that none of the remedies is thoroughly satisfactory. Kocher, MacEwen, Andrews. Ferguson, MacArthur, Championièrre, McBurney, Pitzman, Hoguet, Downes, Stettin, Harrison, Wolfler, Fournel, Quain and La Roque are a few of the earlier and more recent writers to suggest modifications of technic. In practically every instance the modification is aimed not at simplification of the operative procedure, but at reducing the rate of recurrence. We have included in this list of names no one who has suggested a modification of technic to meet a special indication, such, for example, as sliding hernia, voluminous hernia, bladder hernia, bilocular hernia or such like. In a very recent and exhaustive study, Oudard and Jean arrive at the conclusion that "the Bassini operation ought to be abandoned."

If we accept as true the statement that high-sac ligation, restored abdominal wall and primary wound-healing are the essentials to perfect cure, it is clearly evident that proper sac ligation and proper wound-healing are to the largest degree under the control of the surgeon. Both of these factors may be dismissed as comparatively insignficant agencies in the causation of recurrence. May the same be said of the restoration of the defective abdominal wall? For over thirty years this restoration has been effected mainly by suturing the internal oblique and transversalis muscles and their conjoined tendon to the inguinal ligament of Poupart. Does this procedure, (the main reliance of the modern hernia operator) really accomplish the intended purpose?

The answer to this question may be sought in the operating

room and in the laboratory. For several years I (M. G. S.) have directed special attention to the relationship between Poupart's ligament and the internal oblique and transversalis muscles and their conjoined tendon. In none of my operations upon recurrent inguinal hernias have I ever seen these muscles and the conjoined tendon firmly attached to Poupart's ligament. In practically all instances these structures are widely separated just as if they had never been approximated by suture. More than that, Poupart's ligament almost invariably has a strikingly intact appearance, free from thickenings or adhesive cicatricial bands such as one might naturally expect to exist. Coley[1] states that the muscles remain attached to Poupart's ligament, and he bases his statement on the two facts that his recurrence percentage is small and that in his operations for recurrence he finds the internal oblique muscle "firmly united to Poupart's ligament, nearly down to the pubic bone." With much hesitancy and reluctance we doubt the soundness of Coley's observation, just as, with similar hesitancy, we are inclined to question the value of his statistical methods in arriving at the conclusion that his recurrences numbered only 6 in 740 operations (0.8 of 1 per cent).

Several colleagues have stated verbally that in their operations for recurrent inguinal hernia they also find Poupart's ligament, as a general rule, smooth, glistening and free from attachments to the muscles to which they had been sutured previously. Oudard and Jean[2] report their experience to be similar to mine. They find no trace of union between Poupart's ligament and the muscles in their operations for recurrence. Harrison[3] also says that a careful study of approximately 100 reoperated inguinal hernias (personal communication) has convinced him that the suture of Poupart's ligament to the abdominal muscles does not result in a close apposition of these structures.

There is usually rather dense scar tissue union between the posterior surface of the external oblique fascia and the underlying sheath of the internal oblique and transversalis muscles. These dense adhesions usually create the unfortunate impression

that "things are all glued together;" but if one will patiently divide these superficial adhesions and thus release the outer flap of the external oblique he will find that it leads him down to an unattached Poupart's ligament.

Why should this be the case? It goes without saying that if the muscles are anchored to Poupart's ligament under tension the union will be an uncertain one at best. But is tension the only factor that militates against union? Exactly what happens when muscles is sutured to fascia? A diligent search of the literature failed to bring to light a single study of fascia-muscle wound-healing. It was necessary, therefore, to institute these studies in the laboratory, where 50 experiments were done on dogs under ether anesthesia.

The inguinal canal of the normal dog is so snugly and completely closed as not to permit of additional suturing. It was decided, therefore, to study the union of the fascia lata of the thigh to the underlying group of muscles. Through a three-inch longitudinal incision placed at the anterior and upper portion of the outer aspect of the thigh the fascia lata was exposed and incised longitudinally for about 2 inches. A free edge of the fascia was then folded back on itself, imitating the reflection of the external oblique fascia to form Poupart's ligament. The reduplicated edge of the fascia was then sutured to the under lying muscle. This suture of muscle to fascia was always done so that there was no tension whatsoever on the sutures in order to obviate all possibility of the separation of fascia from muscle by pull. Different types of suture (continuous, mattress and interrupted) and different types of suture material (catgut and silk) were used. In some of the experiments infection was courted by slovenly technic, in order to observe the effect of suppuration on subsequent muscle-fascia union. In another group of animals the muscle was traumatized by excising a thin wedge and then the reduplicated fascial edge was sewed into the traumatized portion of the muscle. By this means the influence of trauma on union could be observed. And finally in another set of experiments fascia was sutured to fascia in

order to observe the type and strength of union that resulted. The topic of wound-healing of fascia to fascia may be dismissed at this point, with the statement that in all the experiments the union was perfect and strong, and so smooth that the site of suture could be determined with difficulty, even under the microscope. At the end of periods varying from one to three months the animals were anesthetized and killed, and the fields of previous operative attack studied macro- and microscopically. By way of summarizing the result of the experiments, it may be said:

1. In every instance of clean wound-healing the fascia was widely separated from the muscle to which it previously had been sutured. A very thin and translucent membrane of areolar tissue bridged the gap between fascial and muscle edges. The non-absorbable sutures usually cut their way through the muscle (it has already been stated that there was absolutely no tension on the suture line) and hung in the fascial edge. In some instances there occurred along the sutures a reactionary fibrosis which appeared as opaque white streaks in the delicate layer of areolar tissue already described. It seemed to make no difference whether catgut or silk were used or whether the suture was applied continuously or interruptedly, the muscle and fascia would not establish a close union in wounds that healed by primary union.

2. In every instance of wound-infection the fascia was separated widely from the muscle to which it previously had been sutured. In these instances of wound infection the layer of delicate areolar tissue described above was usually absent, but the reactionary inflammation about the sutures was more marked than in the clean wounds. These streaks of heavy connective scar tissue bridged the space from muscle to fascia. In no instance (where infection occurred) was there a solid sheet of heavy connective tissue uniting the edges of the separated muscle and fascia. In these infected wounds, therefore, we never saw either direct union of muscle and fascia or even continuous indirect union through a solid, uninterrupted layer of cicatricial connective tissue.

3. In every instance where the muscle was traumatized, by excising a wedge so that the fascia could be sutured in the raw trough, there was an attempt at direct union between fascia and muscle. This union was complete in only one instance.

Before studying the wound-healing microscopically a histological study was made of the normal relationship between the fascia lata and the underlying muscles in a dog. This study showed that the fascia lata lies loosely on the muscles and is not only not united to them directly but is really separated from them by loose areolar tissue.

The histological relationship between the fascia lata and muscle was then studied two weeks after suturing the muscle to the fascia with interrupted sutures. It was found that along the sutures there was an extensive reactionary leukocytic (polymorphonuclear) infiltration; whereas between the sutures the fascia merely lay against the muscle as it does normally. In other words, the sutures seem to set up a definitely limited inflammation which binds the muscle and fascia together at the immediate sites of the inflammation. Between these sites there is no union, and as the inflammation subsides the binding power of the inflammatory exudate disappears.

From this group of experiments, therefore, it seems logical to infer that the mere apposition of muscle to fascia does not ensure a firm and lasting union between these fundamentally different types of tissue. Wound suppuration seems to favor a partial cicatricial union. Trauma (to the muscle) seems to make it possible in certain instances to secure a direct and fairly strong union between muscle and fascia.

In view of the fact that the fascia united with traumatized muscle (partially at least in some instances and firmly in one experiment) it became necessary to study the details of wound-healing in the presence of muscle trauma. In order to do this a pedicled flap of fascia lata was made, the underlying muscle was tunneled with a knife, and the fascial strip was laid in the raw muscle tunnel and sutured in *situ*, without tension. After periods of eight to twelve weeks the area involved was excised

and the relation between fascia and muscle was studied histologically. These studies showed that wherever the fascial strip came into contact with intramuscular connective tissue (perimysium) it fused with it and became firmly anchored. Wherever, on the other hand, the perimysial tissue was scanty the fascial strip lay in its tunnel, with practically no evidences of union to the muscle about it.

The fact that simple apposition of muscle to fascia does not result in a firm union of these two structures is of fundamental importance and is closely related to the problem of the radical cure of hernia. It is not without interest to inquire whether Nature herself ever directly unites muscle firmly to connective tissue and to determine how this union is normally established. We could only think of two sites in the human or dog where muscle and connective tissue were normally fused: (1) The close fusion of the rectus abdominis muscle with its connective-tissue sheath at the tendinous inscriptions; and (2) the close fusion of muscle and tendon at the site where muscle ends and tendon begins.

As regards the rectus muscle and its union with its sheath at the lineæ transversæ, microscopic studies clearly illustrate how a firm union is established. The sheath sends finger-like processes of connective tissue into the muscle belly. Each process is an integral part of the sheath itself. All along its course through the muscle the tendinous process anchors itself in place by fusing with the various strands of connective tissue (perimysium) that course through the muscle and separate the various muscle bundles or fascicles. These various anchorages result in a firm union of sheath and muscle, a fact well known to surgeons and necessitating sharp dissection when the rectus is stripped from its sheath at the site of these transverse bands. A higher magnification shows with what care these anchorages are made by Nature. Delicate connective-tissue fibrils are given off by the tendinous bands and fuse with the connective-tissue endomysium surrounding the smaller muscle bundles.

The union of muscle and connective tissue at the site of

muscle-tendon junction is somewhat after the same fashion and furnishes the same type of histological architecture as does rectus muscle at the site of a tendinous band. A low-power magnification of tendon-muscle junction of the external oblique muscle of the abdomen shows how the tendon is directly continuous both with a heavy central strand of connective tissue running back for a long distance in the body of the muscle, and also with the sheath of the muscle that clothes its end and becomes continuous with the central strand of connective tissue. This type of union is very strong and can hardly be duplicated by surgery. A high-power magnification of the same field illustrates in greater detail Nature's method of strengthening a muscle and connective-tissue union. The connective-tissue system of the tendon is anchored at innumerable sites to the connective-tissue system of the muscle (perimysium and endomysium and sheath), resulting in practical continuity of muscle and tendon.

Up to this point we have attempted to show that:

1. No success attended our various trials to establish a strong direct union between muscle and fascia except in those experiments where the muscle was traumatized previous to its suture to the fascia.

2. There are very few if any sites in the body where a direct muscle-connective-tissue union occurs normally except in the muscle-tendon system.

3. In these muscle-tendon systems Nature employs a definite type of architecture which we in a measure imitate when we traumatize the muscle, but which we cannot count upon to yield a full measure of success even when we plan our experiments so that there is absolutely no tension at the site of apposition. It goes without saying that where tension is a factor the sutured structures are very likely to pull apart before wound consolidation can take place.

Thus we are led to the practical considerations bearing on the operation of herniotomy. If the experiments here recorded have been executed properly and if the conclusions from them have

been drawn accurately, it is utterly futile and useless to suture the internal oblique and transversalis muscles to Poupart's ligament. These muscles will not unite to the fascial liagment unless they have been deliberately and rather extensively traumatized, and even if they did unite the union would not hold on account of the inevitable tension that occurs when these structures (Poupart's ligament and the muscles) are approximated. Personally we do not believe that even the conjoined tenson often unites with Poupart's ligament when these two structures are sutured. These structures are both connective tissue, but in addition to the inevitable tension which pulls against the suture line there is always present the possibility of the lateral and medial origins of the cremasteric muscle interposing themselves between Poupart's and the conjoined tendon, thus rendering union highly improbable.

Must we then forsake the idea of reinforcing the weak abdominal wall? By no means. We have at our command three or four procedures:

1. We may rely on a strong union between Poupart's ligament and the outer flap of the external oblique. This is a rational procedure; it has been extensively used as a reinforcing procedure under the name of the Andrews modification, and our experiments show that its utility rests on the affinity of connective tissue for kindred connective tissue in wound-healing. We have been using this method, with unqualified satisfaction, for the past two years, a period too short to permit of any more dogmatic statement.

2. We may use the method of Pitzman,[4] which depends upon suturing the separated edges of the transversalis fascia, and ignoring the internal oblique and transversalis muscles and their conjoined tendon. Pitzman very properly emphasizes the great strength of the transversalis fascia.

3. We may use the method of Harrison, which also ignores the muscle-tendon suture and relies on the transversalis fascia suture made after a somewhat different plan than Pitzman's.

4. We may use the method of Slattery,[5] which also relies largely on suture of the transversalis fascia.

5. We may use the method of Gallie,[6] who sutures the muscles to Poupart's ligament, but who uses fascial strips as suture material. Our work shows clearly that these strips will anchor tightly to Poupart's, and they are very likely to anchor very well to the intramuscular connective tissue with which they come in contact as they pass through the muscle. Gallie's method is, of course, bound up with the problem of tension on the suture line and does not appeal to us as strongly as does any one of the other three methods.

By way of summary we may say then:

1. The modern operation for the cure of inguinal hernia is attended with a disconcertingly high rate of recurrence.

2. Normal muscle will not establish a firm union with fascia or ligament.

3. It is therefore a useless procedure to suture the abdominal muscles to Poupart's ligament in the hope of buttressing a weak or ruptured abdominal wall.

4. Fascia unites well with fascia.

5. The weak abdominal wall should be strengthened by the use of one of the methods of securing fascia to fascia approximation.

Bibliography

1. Coley, W. B.: Keen's System of Surgery, 1908, iii, 77; Progressive Medicine, June, 1922, p. 36.

2. Oudard and Jean, G.: Hernies Inguinales Récidivées, Rev. de Chir., 1922, No. 3, p. 143.

3. Harrison, P. W.: Inguinal Hernia, Arch. Surg., May, 1922, p. 680.

4. Pitzman, Marsh: A Fundamentally New Technic for Inguinal Herniotomy, Ann. Surg., November, 1921, p. 610.

5. Slattery, R. V.: Radical Cure of Inguinal Hernia, Irish Jour. Med. Sci., November, 1922, Series 5, p. 389; (abstracted in Internat. Survey of Surg., January, 1923, p. 74.

6. Gallie, W. E., and LeMesurier, A. B.: Living Sutures in Operative Surgery, Canadian Med. Assn. Jour., July, 1921, p. 1.

HERNIA THROUGH THE CONJOINED TENDON—OR HERNIA OF THE LINEA SEMILUNARIS

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This paper deals with a type of hernia which in its anatomy, significance to the individual, its prognosis and treatment, differs as much from the ordinary direct hernia as the latter does from indirect hernia. If any hernia lying to the inner side of the epigastric artery is considered a direct hernia, then this type of hernia is also direct, but if included among the direct hernias it would be necessary to divide the latter into two distinct subclasses. To call them hernias of the linea semilunaris leads to some confusion, because they are located only at one point of the linea semilunaris. Apparently the most accurate designation would be "hernia through the conjoined tendon" using old terminology, or "the falx inguinalis" using the new. This calls attention to its location, and to the fact that the hernia perforates this portion of the abdominal wall and is not a diffuse yielding of it, as is the case with the typical direct hernia.

A brief reference to anatomy may not be out of place. When one opens the inguinal canal of a very muscular subject and removes the cremaster muscle, Hesselbach's triangle is exposed to view. Above, the lowermost fibers of the internal oblique have a thick abrupt margin; the lowermost fibers seem to me to extend inward and but slightly downward to the end of the linea semilunaris, and have little connection with the conjoined tendon. The transversalis muscle emerges below the lower border of the internal oblique, and either quite covers or almost covers

the space down to the inguinal ligament. These fibers arch downward and inward, and at their termination inward there is an area at the inner side of the triangle of firm consistency which is called the conjoined tendon, or falx inguinalis. The weakest portion of this posterior wall, according to the anatomists consulted and clinical experience, is just mesial to the deep epigastric artery, and close to the inguinal ligament. Here, even in muscular subjects, muscle fibers may be deficient. When this is the case, the posterior wall is said to be made up of a fascia transversalis. In subjects of weak musculature, the lower portion of the transversalis is poorly developed, and its giving way marks the starting point of a direct hernia. As the hernia enlarges it spreads across the triangle to the edge of the rectus, and in such cases a conjoined tendon is a scarcely demonstrable structure. In subjects, however, with a strong musculature, one at times encounters an opening, usually circular in outline, in a well developed conjoined tendon, lying close to the rectus border, with Poupart's ligament below and to its outer side having a fairly firm fibrous margin made of conjoined tendon fibers.

This type of hernia is no doubt much less frequent in its occurrence than the ordinary direct variety, but is not by any means a surgical curiosity; all surgeons of experience with hernias must have encountered it a number of times. In the preparation of this paper the writer has reviewed the records of 11 cases seen within the last three years at St. Luke's Hospital.

It is rather surprising that one sees so little reference to it in the literature. The older editions of Gray's Anatomy clearly contrast the two varieties, and suggest a different relation in the 2 cases to the obliterated hypogastric artery; Erdmann, in a sentence, says: "Direct hernia often emerges through a definite split in the fascia;" Downes clearly distinguishes the two types of hernia, calling the one direct and the other hernia of the linea semilunaris. He brings out, both in the text and drawings, the different locations and anatomical peculiarities of the two hernias. Most descriptions of direct hernia fail to

mention this variety, hence are inaccurate when hernias of the conjoined tendon are included in the direct variety. The clinical side may be best presented by showing the points of similarity and contrast to direct hernia.

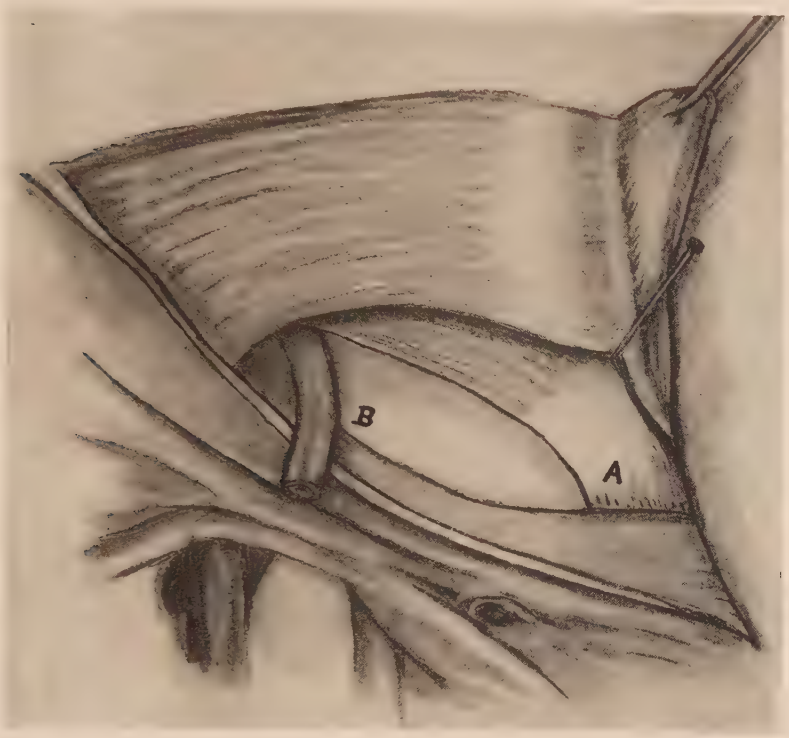

FIG. 1.—Semidiagrammatic dissection of right inguinal region. *A*, location of point of emergence of semilunar line hernia; *B*, usual point of emergence of direct inguinal hernia.

1. Neither direct nor conjoined tendon hernia is seen in children. Direct hernia is practically confined to adult males. Conjoined tendon hernia is seen, but less frequently, in females.

2. Direct hernia has a wide and lax neck often difficult to accurately define. Conjoined tendon hernia has a small tight neck formed by the fibers of the tendon.

3. Conjoined tendon hernia is unilateral; direct hernia is usually bilateral, and is the result of muscular weakness.

4. Direct hernia may be associated on the same or opposite side with indirect hernia; the same has been observed in conjoined tendon hernias. I have even seen a conjoined tendon hernia associated with a fairly definite direct weakness.

5. One of the most important contrasts concerns the liability to strangulation, the small conjoined tendon hernia strangulating with the same ease as does the femoral hernia, while the direct hernia has little tendency to incarceration.

6. They vary also as regards the content of the hernia. The direct hernia may be said to always have a sac; conjoined tendon hernia may consist and frequently does consist only of a mass of prolapsing fat. The bladder is frequently present either with or without a true peritoneal sac.

7. In operating on direct hernia one often sees the obliterated hypogastric artery lying to the inner side of the sac, or arching over its inner portion. In conjoined tendon hernias the hypogastric cord, if seen, has usually been found on the outer side of the neck of the sac. In other cases with a true peritoneal sac present, the hypogastric cord has not been in evidence, but I have been able to satisfy myself that it must lie to the inner side of the hernia. The attempt to draw a distinction between the two types of hernia according to their relation to the hypogastric cord, has seemed to fail as an exact criterion, though it is probably true that the hypogastric nearly always lies to the inner side of a direct hernia, and frequently, at least, to the outer side of the conjoined tendon hernia.

8. The prognosis of conjoined tendon hernia is better and the treatment simpler than that of direct hernia.

9. This hernia presents an oval inguinal swelling quite similar to that of direct hernia, and lies beneath the external oblique aponeurosis, with the conspicuous difference that the swelling is unilateral and usually noted in muscular subjects.

10. As regards diagnosis it may be said that prior to operation, we have several times suspected the conjoined tendon variety

and found it, but in a much larger number of cases have suspected this variety and found the diagnosis incorrect, operation revealing a direct hernia, or an ordinary inguinal bubonocele.

Of the 11 recent cases forming the basis of this report, the ages varied from thirty-three to sixty-two years at the time of operation, the average being 43 plus years. The bladder was present in the herniation a number of times, and was accidentally injured once.

The size of the hernia has varied, a number being quite small, the largest not larger than a hen's egg; four have been incarcerated or strangulated; two strangulated while in the hospital awaiting operation, and were operated upon in the course of a few hours; each contained a knuckle of small intestine. One patient, a woman, aged forty years, complained of a hernia in the left groin, which whenever it protruded, became very hard and painful, compelling her to lie down and maintain pressure until the swelling disappeared. Other conditions made an abdominal section necessary, at which a calcified tumor, as large as a walnut, was discovered in the left ovary. This could be readily pressed up into the hernial sac, which had a tight neck just admitting two fingers, and which lay to the inner side of the obliterated hypogastric artery.

One hernia of this group recurred promptly after operation. The patient was a man, aged fifty years, who had worn a truss for some years; for three days he had had a tender mass at the external ring, and there had been vomiting and general abdominal pain. Operation revealed a strangulated herniated mass protruding through an opening in the tendon three-fourths of an inch in diameter. The mass appeared to be inflamed fat; on investigating this mass in the search for a hernial sac, a cavity was found containing considerable turbid, fibrinous fluid. A finger inserted into this cavity entered the abdomen; further investigation, however, showed that the finger had not entered the peritoneal cavity. A sound in the bladder demonstrated that that organ was not in the hernia, and that it had not been injured. The hernia then consisted of a mass of fat from the prevesical

space which had become strangulated, with considerable fluid exudation both within the abdomen and outside the constricting ring. Three stitches closed the opening and a Bassini operation was added. A drain was left in the lower angle of the wound. The hernia has recurred and is partially controlled by a truss. The patient's lower abdomen is very fat and prominent.

This is the only recurrence in the group of 11 cases, but I recall another hernia of this type in a woman operated on more than ten years ago which required a subsequent operation, and so far as I know has since remained cured.

The treatment of this type of hernia is comparatively simple. One should be careful not to let a conjoined tendon hernia escape observation when operating for an indirect inguinal hernia. This might very well occur when the hernia is small in size, and would give one the impression later that the original hernia had recurred. When the opening is small it is readily closed by one or more mattress sutures. At times the upper margin may be brought down to Poupart's ligament. One of the ordinary operations for strengthening the posterior abdominal wall may be added. The question comes as to what should be done with the hernias of larger opening, or recurrent hernias like the one mentioned above. In addition to closing the opening in the fascia, one might consider the lateral displacement of the rectus margin, suturing it to Poupart's ligament, thus attempting to bring this muscle behind the opening in the conjoined tendon. Another possibility would be to fortify the opening by a reflected portion of the anterior rectus sheath. It would add additional security to this region if the cord were brought out superficial to the external oblique, with closure of the external abdominal ring.

References

Downes, W. A.: Management of Direct Inguinal Hernia, Arch. Surg., No. 1, i, 53.

Erdman, Seward: Inguinal Hernia in the Male, Ann. Surg., 1923, lxxvii, 171.

Gray's Anatomy, American edition, 1887.

THE USE OF FREE TRANSPLANTS OF FASCIA AS LIVING SUTURES IN THE TREATMENT OF HERNIA

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(By Invitation.)

Recurrence of hernia after presumably satisfactory operations is much more frequent than is ordinarily supposed. The records of our army hospitals have demonstrated a very surprising percentage of failures among patients who were otherwise fit for general service, and who, owing to their youth and muscular development, are considered the most satisfactory risks for operative treatment. Not only did this apply to direct inguinal hernias and ventral hernias resulting from wounds or previous abdominal operations, but also to simple oblique inguinal hernias. The opportunity afforded by the collection of a large number of these patients over a short period of time led us to a clinical and experimental investigation of the subject which has resulted in the formulation of some conclusions as to the cause of the failures and in the elaboration of a remedy which we think will lead to their reduction.

After operations for the cure of oblique inguinal hernia, recurrence takes place in a variety of ways. In some cases the hernia reappears in the cord and is probably due to incomplete removal of the sac. In many, however, the recurrence is in the form of a direct hernia and must be accounted for in most instances by damage done to the abdominal wall during the

first operation. In looking for an explanation of the development of these direct hernias, we found that in all our cases the external ring was wide open, which may have resulted from improper suture of the split external oblique aponeurosis or from stretching of the scar in the line of union after the sutures had been absorbed. Whatever the cause the result was the same, namely, the production of an area in the anterior wall of the inguinal canal which was unsupported by aponeurosis, through which the fascia transversalis and peritoneum are forced during periods of increased abdominal pressure. In all the operations the internal oblique muscle and conjoined tendon had been sutured to Poupart's ligament either in front of or behind the cord. In some instances at the time of the second operation there was no evidence to show that such an operation had ever been performed, and it was evident that the muscle and tendon must have returned to their normal positions soon after the sutures had been absorbed. In the majority, however, the muscle had adhered in part particularly toward the outer end of the canal. Toward the inner end the muscle had either completely separated from Poupart's ligament, leaving it smooth and shiny as in its natural condition, or the hernia had pushed through the muscle itself, close to the ligament, leaving a few bundles of muscle firmly adherent to it. The most important observation, however, was that in no case did we find any evidence of adhesion between the conjoined tendon or the sheath of the rectus and the ligament. In every instance the aponeurotic structures which had been sutured to the ligament had returned to their normal positions, leaving an area of weakness which the original operation had been designed to strengthen. It was through this portion of the inguinal canal that the hernias protruded. From these observations we were convinced that the simple side-to-side suture of the muscle and the conjoined tendon to Poupart's ligament is an untrustworthy method of supporting the posterior wall of the canal, and it has raised in our minds a doubt as to whether even in successful operation it plays an important part in the cure.

Our observations on direct hernias which had recurred agreed closely with those made on oblique hernias. In addition to the suture of the internal oblique muscle and conjoined tendon to Poupart's ligament the records showed that in many instances the sheath of the rectus and the abdominal aponeurosis had also been dragged down to the ligament and fastened there with heavy chromicized catgut or kangaroo tendons. In none of the cases had permanent adhesion taken place and the recurrence had developed for precisely the same reason that had produced the original hernia. Our experience with direct hernia was such as to convince us that all of the methods employed to close the posterior wall of the canal were exceedingly uncertain, and that even successful operations were largely a matter of chance.

The ventral hernias which had recurred after operation simply showed that the muscular or aponeurotic structures which had been sutured had failed to heal together firmly, and our operations showed a protrusion of parietal peritoneum covered with more or less thinned-out scar tissue. In some of the cases the aponeuroses had been simply drawn into edge-to-edge apposition with heavy absorbable sutures, but in others the various layers had been carefully overlapped. Our conclusion was that here again the ordinary operations leave altogether too much to chance and that some radical change must be made in the operative technic before a cure can be expected with confidence.

Among the ventral hernias admitted for treatment were several in which large areas of the abdominal wall had been destroyed by shell wounds and in which huge hernias were covered only by a thin layer of scar. These cases were considered inoperable and had been sent to hospital to be supplied with some form of abdominal belt. It was these cases in particular that set us thinking of ways by which large gaps in the abdominal wall might be closed and that led to the experimental investigation, of which this paper contains a review.

The experiments were performed on dogs and rabbits. They consisted of a series of operations in some of which simple wounds in fascia, aponeurosis and muscle were sutured with

catgut and linen, and in others, pedunculated and free transplants of aponeurosis and fascia were sutured into gaps in these structures. A detailed account of these experiments has been given elsewhere,[1] but the findings may be summarized as follows:

1. Wounds in fascia and aponeurosis, when sutured in edge-to-edge apposition with absorbable sutures, heal together by means of delicate scar tissue which develops from the areolar membrane which invests the surfaces and from the loose connective-tissue stroma which separates the bundles of fibers. This scar is not strong, and if the wound is subjected to strain it slowly stretches, leaving a gap between the edges of the wound which is filled with areolar membrane continuous with that on the surfaces of the aponeurosis or fascia (Fig. 1).

2. When linen sutures are used the tendency to opening up of the wound when under strain is not so marked. The sutures themselves assist in holding the edges together and the scar in the region of the sutures is more abundant and denser than when catgut is used. In many cases, however, the linen cuts out and the edges of the wound spread apart exactly as when absorbable sutures are employed.

3. The simple overlapping of the edges of the wound adds little or nothing to the solidity of the healing. By this procedure the overlapped edges are not placed in actual contact, as the areolar fibers on the surfaces are interposed. These adhere to one another lightly, but any degree of strain causes the edges of the wound to draw apart. The process of overlapping increases the degree of strain and thus tends to defeat its own object.

4. If before overlapping the edges of the wound the areolar membranes on the surfaces be thoroughly removed and the areas which are placed in contact scraped and otherwise damaged the degree of adhesion is much increased. The scar between the overlapped layers is more dense, and it has a deeper grip on them than under any other circumstances. Prolonged and unusual strain, however, results in stretching of the scar just the same as in the other methods of suture.

[1] Canadian Medical Association Journal, July, 1923.

5. Side-to-side suture of undamaged folds of aponeurosis, such as is done in the suture of the conjoined tendon to Poupart's ligament, never results in permanent adhesion even under the slighest degrees of strain.

6. Scarification of the surfaces of the folds before suture, increases the degree of adhesion, but not to any great extent.

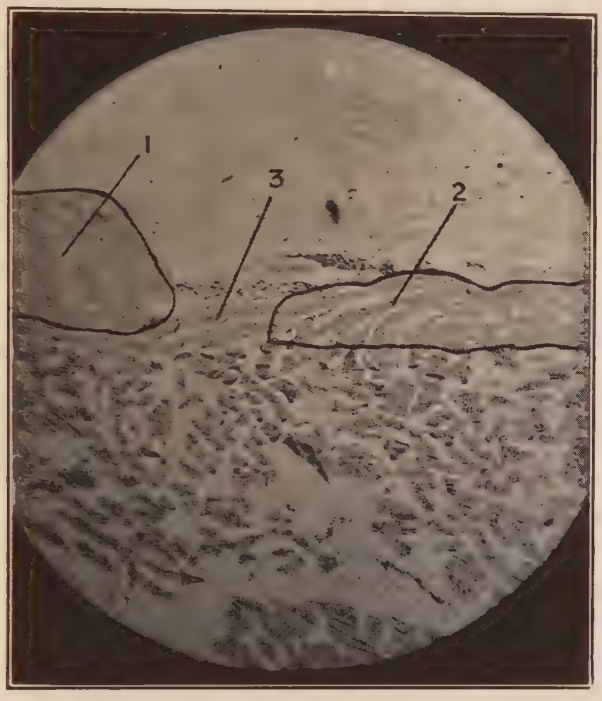

FIG. 1.—Stretching, under strain of scar tissue formed between the edges of a wound in aponeurosis. The specimen was recovered thirteen months after the wound was sutured. 1, 2, aponeurosis; 3, scar tissue.

7. Side-to-side suture of undamaged muscles which in contracting tend to draw apart, such as suture of the two recti muscles in the middle line of the abdomen, results in the lightest possible adhesion, which disappears in a very short time.

8. Preliminary scarification and scraping of the sides of the

muscle before suture adds greatly to the solidity of union. This is due to the injury done to the connective-tissue stroma of the muscle and is responded to by the formation of a firm scar which has a solid grip on the depths of the muscle.

9. Side-to-side suture of muscle and aponeurosis, as in the suture of the internal oblique muscle to Poupart's ligament, results in union of practically no strength. The strength of union is increased by preliminary damage to the sutured surfaces, but to a much less degree than in the suture of muscle to muscle. This is due to the fact that the smooth, shiny surface of the aponeurosis allows very little opportunity for a scar to get a solid grip of it.

10. Pedunculated or free transplants of fascia and aponeurosis if placed in such a position that they can receive an adequate supply of lymph continue to live unchanged.

11. Such transplants, when used to fill anatomical defects such as occur in inguinal and ventral hernias, heal to the structures to which they are sutured in exactly the same manner as has already been described in the healing of simple wounds in these tissues. If the edges are brought accurately together or are overlapped without scarification the degree of adhesion is only such as is provided by a delicate areolar tissue. If they are overlapped and subjected to considerable damage they unite by a generous scar. In the former case the slightest strain will cause the separation of the edges, but in the latter the union is more solid and often tolerates what may be considered normal degrees of strain. If the strain, however, is unusual or prolonged the scar behaves exactly as it does elsewhere under similar conditions, and slowly stretches (Fig. 2).

From our clinical experience, therefore, and from the information derived from our experiments, we have come to the conclusion that operations designed to produce permanent adhesion between aponeurotic structures which naturally tend to separate are defective in principle if they depend solely on the process of healing in the line of suture. Herein lies the explanation of the high percentage of recurrences in large ventral hernias and in

direct inguinal hernias, even when the operations have been performed by most competent hands. Before this percentage of failures can be eliminated, some method must be discovered

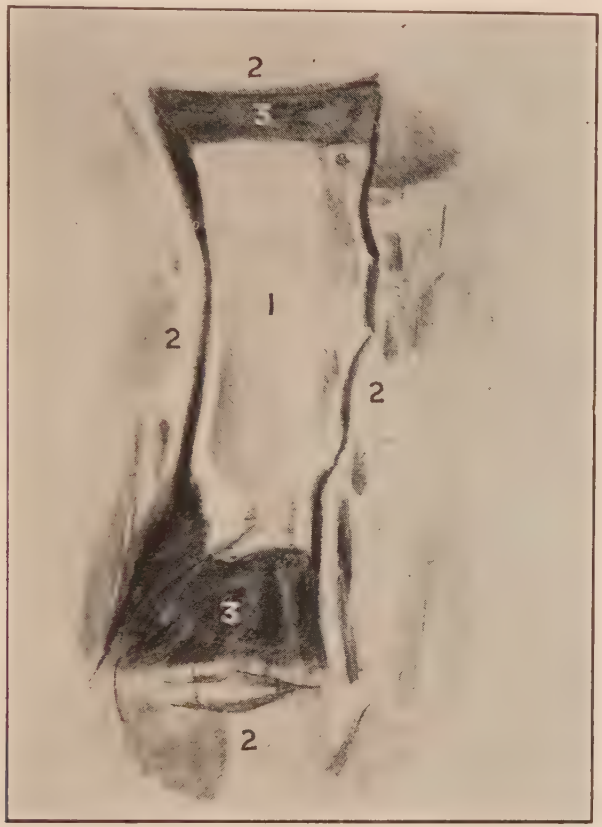

FIG. 2.—Transplant of aponeurosis after thirteen months. 1, transplant; 2, edges of normal aponeurosis; 3, thin scar uniting the two. At the operation the transplant was accurately sutured all around its edge to the normal aponeurosis. Union has taken place by scar tissue, which, even under the moderate strain present, has stretched considerably.

of removing the element of chance which always attends dependence on the strength and resistance of scar.

It was while we were considering means of overcoming this

difficulty that the idea presented itself to us of using transplants of fascia lata as living sutures, which might permanently hold the edges of hernial rings together without depending upon the natural process of repair. Before trying this method on patients, we did a series of experiments on animals in which strips of fascia, a quarter of an inch wide, were removed from the back, and then used as sutures to hold together the edges of the opening so produced. These edges were left about a quarter of an inch apart in order that the whole test might be placed on the sutures without any assistance from scar tissue. The specimens were recovered at intervals of from one week up to two years. As in the case of ordinary patch transplants the fascial sutures continued to live practically unchanged. By means of a special apparatus we were able to demonstrate that their tensile strength remains constant, and by fastening to them black silk markers at accurately measured intervals, that they neither stretch nor contract. As a result of passing through a needle hole, they become folded into rounded cords which soon become surrounded with a delicate vascular membrane, such as is normally on the surface of fascia. From this membrane processes of similar tissue project inward among the folds of the suture, and when the early inflammatory reaction has subsided and the newly formed connective tissue has contracted down to its normal adult condition, the suture appears in cross-section like ordinary normal tendon (Fig. 3). In all the experiments the suture was successful in holding the edges of the gap in the fascia at the same distance from one another as at the time of the operation, in spite of the fact that the animals were under no restraint. It was only necessary to make certain that the suture obtained a solid grip of the edges of the opening to assure the success of the operation.

From these experimental findings we felt sure that in fascia lata we would find a suture material which would be ideal for the closure of hernia. It is easy to obtain in long strips and in any quantity, and its removal results in no disability. It is extraordinarily strong, being simply flattened tendon, and its

smooth, glistening surfaces make it admirable for use as sutures. We have accordingly employed it whenever we have had reason to doubt the certainty of the ordinary methods in establishing a cure and, as time goes on, with steadily increasing satisfaction.

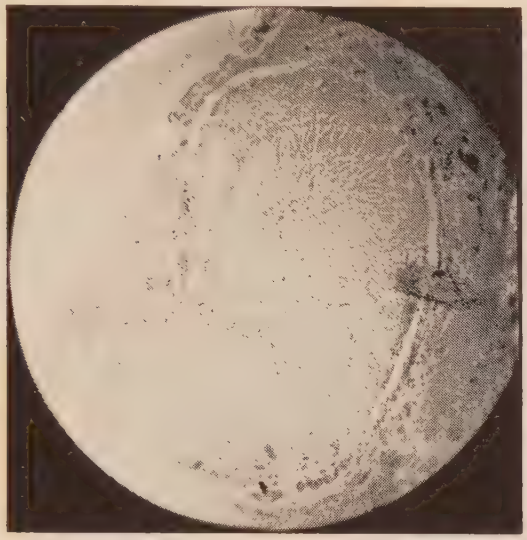

FIG. 3.—Cross-section of fascial suture after two years. The suture is now a rounded cord in which the original folds of the fascial strip are barely distinguishable. It closely resembles tendon, both in the gross and microscopically.

From our experimental and clinical experience certain points in technic have been evolved which have proved themselves of assistance. Great saving of time can be made by having two operators, one to attend to the hernia and the other to look after the sutures. The sutures are obtained through a long incision on the lateral aspect of the thigh, slightly posterior to the horizontal mid-plane. Here the fascia is most tendinous in character. After thoroughly clearing the surface of the fascia of fat and areolar tissue a longitudinal slit is made in it with a knife, and with a pair of blunt scissors the fascia is ripped to the required length, much as a draper rips a bolt of cotton. A second incision

is then made, a quarter of an inch lateral to the first, and one end of the suture thus prepared is cut free. This end is now threaded into a large-eyed needle and tied securely into it with catgut or silk. This is necessary, owing to the slippery character of the fascia, which causes it to slide readily out of the needle. As many sutures as are required are prepared in this way and the wound is then drawn together with towel clips until they are called for. By this means the handling of the sutures is reduced to a minimum, and they are not allowed to become dried by exposure to the air. When the first suture is required the needle is picked up with forceps and the strip of fascia quickly lifted out of its bed and detached. A catgut ligature is tied around its terminal end, to prevent it from fraying, and it is transferred to the hernial wound. The needle is then passed through whatever solid aponeurotic structure is available and then through the terminal end of the suture close to the catgut ligature and drawn taut. In this way a sort of slip-knot is produced which makes an excellent anchor for the stitch (Fig. 4, *1*). A running suture is now proceeded with which draws together the strongest aponeurotic tissue in the neighborhood. It is wise to introduce some form of lock-stitch about every third or fourth bite of the needle, owing to the slippery nature of the fascia, and we have found the most useful one to be a single knot combined with transfixion (Fig. 4, *3*). When the first suture has been used up a second one is started by fastening it to the first, as is done in stringing a tennis racquet (Fig. 4, *5*, *6*), and the sewing is proceeded with as before. To terminate the suture we insert a final lock-stitch and then, detaching the needle, split the strip of fascia into two strands, one of which is passed around the main portion of the suture and tied to the other in a triple knot. This knot is securely fastened by a catgut ligature which transfixes it, with a view to preventing it from becoming untied (Fig. 4, *4*).

The above description of technic applies particularly to those operations in which it is possible to draw the edges of the hernial ring together without too great tension. In these cases, when the process of healing is complete, the edges of the ring are held

together by both sutures and scar tissue, so that the number of sutures need rarely be more than two. When the edges cannot be drawn together, however, the whole strain comes on the sutures and it is necessary, therefore, to make absolutely certain that they get a solid grip of the neighboring aponeuroses and

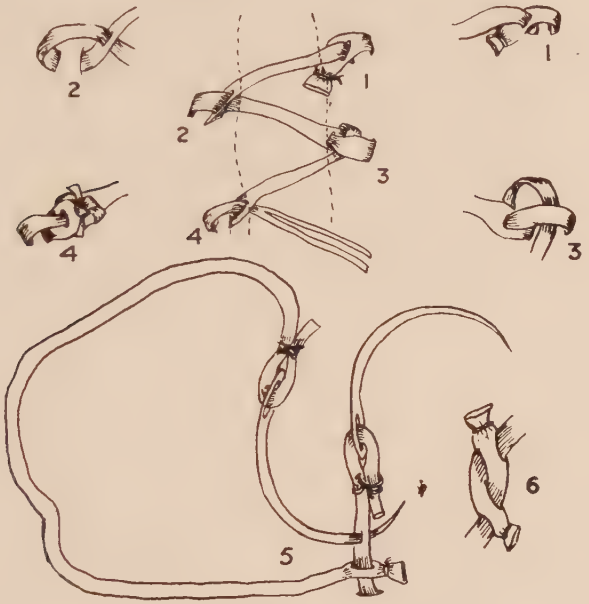

FIG. 4.—Diagram showing technic of using fascial suture. 1, anchoring the suture at its commencement by looping it through itself at its tail end, which is tied with a ligature to prevent splitting; 2, fixation of suture at each loop by passing it through itself; 3, fixation by passing suture through itself and tying in knot; 4, ending of suture by passing it through itself, splitting and tying ends in triple knot. This fixation is further reinforced by transfixing with a catgut stitch. 5, method of joining new suture to one that has been expended; 6, join completed.

muscles, and to use a sufficient number of sutures to fill up the gap completely, and so prevent a hernia from forcing its way through one of the chinks. In such circumstances we weave the sutures across the opening as in the darning of a sock.

In operations on the inguinal canal the same general technic is

observed in all types of hernias. After the sac has been disposed of special care is taken to expose and clear the conjoined tendon and rectus sheath at their insertion into the pubic bone, and also the point of attachment of Poupart's ligament. The split external oblique is turned back until the glistening abdominal aponeurosis is in full view. The fascial suture is securely anchored into the conjoined tendon and sheath of the rectus close to their insertion into the bone and then passed through the periosteum of the spine of the pubis and the inner end of Poupart's ligament. When the suture is drawn taut the weakest spot in the posterior wall of the canal is permanently closed, so that no hernia can force itself through. The suture is then continued in an outward direction, closing the internal oblique muscle down to the recurved edge of Poupart's ligament, behind the cord, until the position of the internal ring is reached. Here a lock-stitch is inserted and the suture is continued to the outer side of the cord and a stitch or two taken to lend additional support. In this way the cord is surrounded in the region of the internal ring by a strong ring of fascia, which should permanently prevent recurrence into the cord (Fig. 5). So far the operation resembles very closely the various well-known operations, with the exception that fascia is substituted for catgut or other suture materials. We are of the opinion, however, that for direct hernias this is not sufficient, as a hernia may recur through the muscle itself. To prevent such a mishap we insert a second layer of sutures which weave the abdominal aponeurosis and the rectus sheath to Poupart's ligament. This suture is continuous with the first, starting at the internal ring and ending at the spine of the pubis (Fig. 6). No attempt is made to drag the abdominal aponeurosis down to Poupart's ligament, as in most cases this would result in tearing the ligament to pieces, but the sutures are simply drawn sufficiently taut to make them lie flat. They are interwoven with the first row of sutures so that a solid mat is produced as in weaving a basket. It is upon this second row of sutures that we depend for strength in closure of the defect, as the anchorage in the aponeurosis and the ligament is absolutely

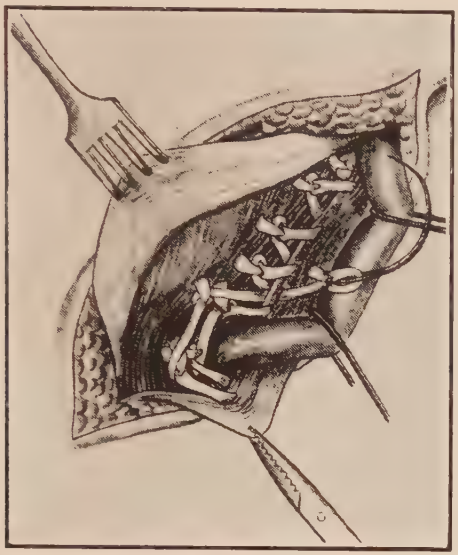

FIG. 5.—Repair of inguinal hernia. Insertion of first row of suture, and reinforcement of internal ring.

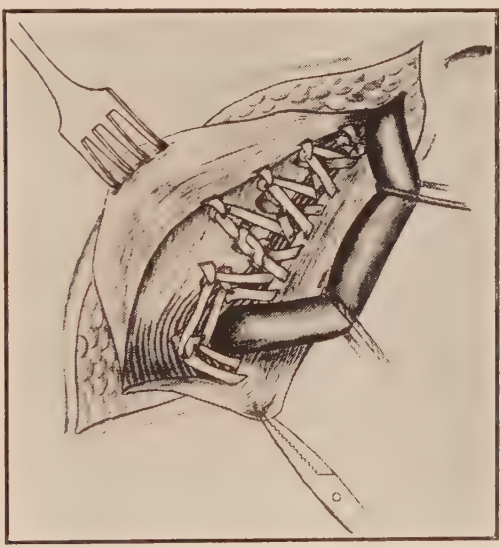

FIG. 6.—Repair of inguinal hernia. Insertion of second row of suture. In practice the sutures are placed somewhat closer together than is shown in the diagram.

dependable and we have no fears in regard to the suture material itself. The only real virtue in the deep sutures is that they permanently cover the peritoneum with a layer of muscle which will prevent the possibility of a hernial protrusion through the chinks in the superficial layer. When the suture has been securely tied we feel that the important part of the operation has been completed. What one does to the split external oblique appears to be of relatively little importance, as it will never be subjected to any severe strain now that the defect in the abdominal wall is closed off. Sometimes we have simply sewn it over the cord with catgut, but in patients who have already had two or three operations we have used another narrow fascial suture. In such cases the external oblique aponeurosis in the region of the external ring is usually very defective, and we have taken pains to make a new aponeurosis in this area by running the suture from the anterior aspect of the rectus sheath to Poupart's ligament and to construct a new external ring which lies in front of the pubic bone, and so is not subject to strain during increases of intra-abdominal pressure.

With this type of operation we have now had an experience extending over four years. During that time about sixty operations have been performed on patients, the majority of whom have been operated upon once, twice or three times previously. In most instances the hernias were of the direct variety when referred to us, although many had originally been oblique. In this series, after the "living suture" operation, there have been no recurrences. We have sufficient confidence in the method, therefore, to recommend it to the Association.

It has been brought to our attention that the principle of using living tissues as suture material has been suggested before. Years ago Vulliet described a method of nephropexy in which he sutured the capsule of the kidney to the abdominal wall by means of a pedunculated strand of the tendon of the longissimus dorsi. In 1901, Dr. L. L. McArthur described a method of procedure in inguinal hernia in which pedunculated strands of the aponeurosis of the external oblique were used in place of catgut in suturing the internal oblique muscle to Poupart's ligament

and in closing the split external oblique itself. As far as we know, however, no one has suggested the use of free transplants of fascia lata as suture material, and no one has used the principle of filling defects in the abdominal wall with a living aponeurotic filigree.

While the results in inguinal hernia have been eminently satisfactory, it is in the large ventral hernias that we have been most impressed with the value of the method. After the sac has been removed or pushed back the muscular and aponeurotic edges of the ring are cleared sufficiently for the insertion of the sutures. In our early operations we simply imitated the well-known overlapping methods, separating the various layers of the abdominal wall from one another and overlapping them where possible. We soon found, however, that this very decidedly weakened the boundaries of the defect, and that whenever it was necessary to draw them together under strong tension the stitches were much more apt to tear holes than when they were left undisturbed as a solid mat. When we fully appreciated that the sutures themselves could be depended upon to remain unchanged for all time, we abandoned all dissection of the edges of the ring and contented ourselves with simple edge-to-edge apposition in the suturing. When it is seen that the boundaries of the ring can be drawn together without too great increase of the intra-abdominal pressure the living suture is anchored at one end of the wound and the opening is closed with a through-and-through running stitch (Fig. 7). The only care taken is to see that the needle always passes through tough aponeurotic tissue, so that all possibility of the stitches tearing out is eliminated. The opening is further supported by a second layer of sutures superimposed on the first, which gets its grip of the abdominal wall at a distance of an inch from the hernial ring, and the suture crosses and recrosses the former opening much as a lace in a shoe (Fig. 8). This row of sutures is not drawn tighter than is necessary to make the strips of fascia lie flat, so that no inversion of the wound occurs. When it is seen that the large size of the hernial ring makes it impossible to draw the edges together, as is frequently the case in extensive shell wounds of

FIG. 7.—Repair of ventral hernia. Insertion of first row of suture.

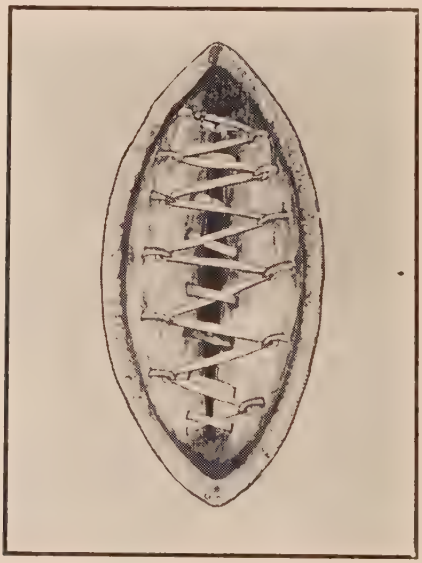

FIG. 8.—Repair of ventral hernia. Insertion of second row of suture.

the abdominal wall or when the edges can only be drawn together under very severe tension by means of Kocher clamps, we abandon all idea of bringing them into actual contact and set about repairing the defect by other means. This may be accomplished by filling in the opening exactly as a woman darns a hole in a sock. The sutures are drawn sufficiently taut to preclude unnecessary waste of material, but under no circumstances so taut as to produce undue compression of the abdominal contents.

This method of suture has proven highly satisfactory in a series of cases extending over four years. Some of the hernias were enormous and the surgeons who saw them considered them incurable. One case we are particularly proud of was a soldier who came in with a hernia half the size of a football, resulting from a shell wound which had destroyed the upper half of the right rectus muscle and a large area of the abdominal aponeurosis. His abdominal wall in this region consisted of an exceedingly thin scar through which peristaltic movements of the intestines were plainly visible. The muscles in the outer edge of the hernial ring had retracted to beyond the anterior axillary line, leaving an opening about 7 inches by 5. This hernia was closed about three years ago by the darning method described, and the man has been working as a laborer ever since without disability. He has very little subcutaneous fat, and in that portion of the wound in which the edges of the ring could not be drawn together the sutures can still be felt something like the ridges on a washboard.

More recently we have been trying out another method in very wide hernias which removes the possibility of a protrusion of a sac through the chinks which remain between the sutures. In this operation two patches of fascia lata are removed from the thigh and trimmed to the right shape to fill the gap in the abdominal wall. An ample margin is left for an overlap. The two pieces of fascia are then laid in the wound, one on top of the other, in such a way that the fibers of the two layers cross one another obliquely, as they do in the various layers of the abdominal aponeurosis. The transplants are then sewn into position by two rows of living sutures which run all the way around the

edges of the opening. One can recognize in this operation a certain resemblance to the old-fashioned patch on the seat of the trousers.

The removal of the fascial sutures from the thigh results in no disability. As a rule, four strips of fascia are all that are required, and following the operation there is no difficulty in closing the opening with catgut suture. In cases, however, where patches were required or where so many sutures were needed that the opening in the fascia lata could not be closed, the patients have made no mention of their thighs, and no deformity or disability has resulted. The wound in the thigh does not lengthen the period of stay in bed.

We now have records of approximately one hundred hernias of all varieties which have been closed by means of living sutures. In this series there have been, up to the present, no recurrences. Three cases have suppurated, but fortunately the suture was not extruded and no ill effects have ensued. This is probably due more to good luck than to any virtue in the method of suture. Among these hernias were many which we feel sure could not have been cured by the ordinary methods of operation, and we are therefore very hopeful that the use of living sutures will make a decided reduction in the percentage of recurrences and considerably widen the field in which operative treatment is applicable.

The method is recommended for the following conditions:

1. Direct inguinal hernia.

2. Oblique inguinal hernia in patients at or beyond middle age, particularly where the canal has lost its obliquity and where the abdomen is becoming pendulous.

3. Femoral hernia. In this the suture is used to close the entrance of the femoral ring through an inguinal incision.

4. All forms of recurred hernia.

5. All ventral hernias in which there is any doubt in the surgeon's mind as to the permanence of closure by the ordinary methods.

6. Ventral hernia in which closure can be obtained only with disquieting increase of intra-abdominal pressure.

DISCUSSION ON THE PAPERS OF DRS. SEELIG, MATHEWS AND GALLIE

Dr. Charles N. Dowd, New York:

I wish to record a case which shows that sometimes there is a lasting union between Poupart's ligament on one side and the internal oblique muscle and transversalis muscle or fascia on the other side when these structures are sewed together in the Bassini operation for the repair of inguinal hernia.

The question was discussed at the New York Surgical Society a few years ago and at that time I operated upon a patient for whom Dr. Alexander Johnson, a former member of this Association, had done the Bassini operation eleven years previously. I found a firm union between Poupart's ligament and the internal oblique and transversalis, medial to the reconstructed internal ring. This union was two inches or two and a half inches in extent, and since it had endured eleven years it furnishes good proof that such union is possible.

Dr. A. A. Law, Minneapolis:

It is now well established that the technic of transplanting autografts has crystallized into as definite a line of procedure as other standarized surgical methods. It is also established that we can with impunity make an autogenous transplant of any of the tissues of the connective-tissue group, of simple histological construction, such as bone, fascia, fat, tendon or skin. I was much interested in Dr. Gallie's paper because he again calls the attention of the profession to the use of strips of living sutures which Dr. L. L. McArthur originated and reported many years ago. Nearly ten years ago we began to select cases where in large umbilical hernias there was marked diastasis of the recti muscles, with fatty infiltration and atrophy of the aponeuroses. After the Mayo transverse umbilical repair had been done, we felt no assurance that the tissues would withstand the increased intra-abdominal pressure incident to the return of bowels which had lost their habitat. Again, in selected cases of very large inguinal hernias, where there was much atrophy of tissue, we felt we could not be sure of the repair holding. In these cases we began to reinforce our operative repairs with fascia lata. In 15 instances where we used fascia lata there has been no recurrence of the hernia. We did not use the small strand of fascia as reported by Dr. Gallie but rather the massive sheets of fascia lata which were tacked down as patches to reinforce the operative

field. An unhappy experience with the silver filigree screen used to reinforce large umbilical hernia repairs led us to try the use of fascia. It is axiomatic in all autogenous transplantations which must receive their primary nutrition by osmosis from the plasma until such time as new bloodvessels are reëstablished that the smaller the graft used the greater is the certainty of their survival, yet in the instance of fascia lata, which is a tissue of extremely simple histology and low vascularization, we have successfully transplanted a free graft of nine inches square, this graft being tacked over a Mayo transverse restoration of a large umbilical hernia. All of my grafts used in both umbilical and inguinal hernias have survived and successfully reinforced the operative field. We know, according to Roux's law, that any autogenous graft must be given specific work to do if it is to survive and retain its identity. If it is not given its work it either becomes absorbed, converted into connective tissue or extruded. In large sheets of fascia lata transplanted into the abdominal wall and tacked down to the underlying tissues, through the strain incident to the abdominal respiratory effort and the intra-abdominal pressure enough demand is made upon these grafts in the way of specific work so they retain their identity as fascia lata and reinforce whatever surgical procedure has been done. While not germane, this same phenomena has been repeatedly noted where fascia lata has been utilized as tendons and where bone transplants have been required to sustain weight. In the latter instance not only do they retain their identity as bone but hypertrophy to meet the physiological demands put upon them. We believe that it is now conclusively proven that the fascia lata, whether used as sutures or as a large transplant in augmenting hernia repairs, has established itself as a useful, reliable and authentic surgical procedure.

Dr. Henry H. M. Lyle, New York:

My personal experience with Dr. Gallie's operation has been limited and my cases of too recent date to furnish any definite conclusions, but as far as I have gone I have been impressed with its value in certain types of hernias.

In large, long-standing hernias and in bad recurrences it has a distinct field of usefulness. One of my personal cases was a large hernia of years' standing in a man aged sixty-four. He had been refused operation by other surgeons and the truss-makers had also given him up. A satisfactory closure was obtained by the Gallie method and six months after there is no sign of recurrence. Another case was a hernia in a soldier which had recurred twice; the last

recurrence was uncontrollable and so disabling that he could not work. This patient had been deemed inoperable by two rating boards and three competent surgeons. The repair proved to be difficult on account of the destruction of tissues at the previous operations. I doubt if a satisfactory closure could have been obtained by any other method than Gallie's. The man has returned to work, and seven months after there is no sign of recurrence. In 3 other cases of recent date satisfactory closure was obtained.

We have reserved Gallie's operation for difficult cases, especially the recurrent ones in which the standard operations appear to offer no hope of cure. We are tentatively extending the method to direct hernias with the object of reducing our per cent of recurrences.

Regarding Dr. Seelig's excellent paper, I would like to go on record that at a recent autopsy in a patient who died from malignant disease I had an opportunity to examine an old Bassini operation scar. The internal oblique and conjoined tendon were firmly united to Poupart's ligament, and they could not be separated. The possibility of the union of the muscle to Poupart's can be settled if the members of this Association would collect the facts from the autopsy room. Among the autopsy material of the hospitals there must be a certain number of cases that have been successfully operated on for hernia.

We have heard about the "unholy union" which takes place between Poupart's ligament and the muscle as seen in the recurrent cases, but not a single word about this union in successful cases of Bassini repair. *This is the knowledge we require.*

Dr. David Cheever, Boston:

Dr. Seelig's beautiful demonstration of the futility of suturing the muscle fibers to Poupart's ligament, and Dr. Gallie's very convincing demonstration of one way to avoid it, make it reasonable, perhaps, to propose a somewhat novel method of curing inguinal hernia. Underlying all these new procedures is the widespread recognition that old methods are by no means always successful. This new method consists in withdrawing the testicle from the scrotum, incising the transversalis fascia forming the floor of the inguinal canal and slipping the testicle down through the femoral canal beneath the ligament and between the vein and Gimbernat's ligament out through the saphenous opening and back into the scrotum. This will sound fanciful to you, but it is apparently perfectly practicable, and I have carried it out in 5 cases with apparent success. (Demonstration with lantern slides.)

Dr. Leonard Freeman, Denver:

This question of the use of fascia for hernia is, of course, an old one. I have been using the method for the last ten years in large ventral hernias and in bad inguinal hernias with a tendency to recurrence. I do not think the value of the method can be questioned. The fascia can be used either as a suture or as a patch.

In the suture method we simply bring together the *edges* of the different structures which we wish to unite. When a patch is used we not only hold the edges together but we have a large area of fascia spreading out over the adjacent tissues, which adds to the stability. Having used the fascial patch in a sufficient number of cases and in sufficiently bad cases with good effect, to prove that it is efficient, I am quite satisfied to continue with it. I can say that in none of my cases in which I have used a fascial patch have I had a recurrence. I think that success is due to the patching action of the fascia more than to anything else, even when it is used as a suture.

Dr. L. L. McArthur, Chicago:

I am particularly gratified with the paper of Dr. Gallie, both because his paper and his illustrations can be found in the *Journal of the American Medical Association* in almost identical form.

The difference in the location or source of the flap of fascia perhaps makes a complication in the operative procedure. It makes two wounds instead of one. It is quite easy to identify the two borders of the ring. They both terminate where Nature left them at the spine of the symphysis. Leaving them attached there instead of attaching them by a catgut suture, seemed to me more feasible, then splitting up the rectus where one can get usually four to six inches of wide fibrous elastic tissue with which to close your hernia. If you prefer to do as was suggested by Dr. Bevan, suture one layer to the margin of the shelving edge of Poupart's ligament, one strand can be used for that. If you prefer to bring them together by the other method, one can lace up the canal just as a shoe is laced up.

It has been my good fortune to have a specimen from a human being secured three and a half years afterward, the patient having died of an acute gangrenous appendix and having been recognized by the members of the hospital staff as one of the early hernia operations that I had done by this method.

Whether you use the fascia suture or whether you use kangaroo or catgut, if you oppose two fairly broad surfaces of elastic tissue like the layers of the external oblique after the method which Andrews

originate makes little difference. This method appeared in the literature eight years before it appeared on the Continent, where it is known as the Girard in Switzerland and the Monier. It is about the same as if you put two pieces of adhesive plaster together and tried to separate them at right angles—it is almost impossible. Forty-eight hours after the tissues have been approximated in that way they will hold, and will hold well.

I confess that I have done very few tendon plastic sutures in the last ten years, and these only with very large wide openings that could not be approximated, and then I laced them up as a shoe is laced. Then these large gaps can be likewise closed and efficiently closed because of the living flap. Dr. Andrews, years ago, recommended the application of this suture to ventral hernia.

THE DISABILITIES OF THE HAND AND THEIR PHYSIOLOGICAL TREATMENT

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Anatomical and Physiological Considerations. The hand is such a complicated organ that a knowledge of its structure and function is essential to the successful treatment of the individual lesions. In the treatment we must not lose sight of the fact that the hand, in addition to being a marvelous mechanism capable of the most delicate and intricate movements, is also a highly specialized sense organ.

The Position of Rest. (*Physiological Balance.*) In the mechanism of animal life it is a universal law that periods of activity are followed by periods of rest. The normal physiological position of the hand is simply an expression of the state of rest of the muscles, joints, nerves and vessels, the balance being maintained by the resting tone of the muscles. If you examine your own hand as it hangs by your side you will find that the arm is slightly pronated, the wrist dorsiflexed, the palm hollowed and the fingers bent toward the palm. The little finger is flexed the most, then the ring next, then the middle; the index is relatively extended when compared with the others. The palm is hollowed from side to side as well as in its length.

If the hand is to be rendered passive by a splint this splint must fulfil the following conditions: It must maintain the hand in the physiological position of rest, preserve the normal arches of the hand and allow suitable motion.

The Arches of the Hand. The hand is made up of three main arches, one longitudinal and two transverse. The longi-

tudinal arch has as its bony arch the moderate palmar curve of the metacarpals and the slight curve of the carpus. The arch is accentuated by the disposition of the fascia in the hollow of the hand and by the fact that in the position of rest the fingers are slightly flexed.

Of the two transverse arches the proximal or wrist arch is a deep, trough-like structure formed by the carpal bones. This trough carried the flexor tendons, its roof is formed by the annular ligament, its radial wall by the trapezium and the semilunar and the ulnar wall by the unciform and pisiform. The tendons of the long muscles which flex the fingers use the hook of the unciform as the ulnar fulcrum and the trapezium as the radial fulcrum, the greatest force coming against the trapezium. Any relaxation or flattening of the arch weakens these lateral fulcrums and forces the tendons to work at a great mechanical disadvantage.

The distal transverse arch has a gentle palmar curve and is formed by the heads of the metacarpals. It is a broader arch than the carpal and is increased in depth when the hand is used, due to the flexibility palmward of the fourth and fifth metacarpals.

The arches of the hand are not to be considered as mere bony frameworks, but as living, functionating structures composed of bones, joints and ligaments, the functional integrity of the whole depending on a healthy musculature. The intrinsic muscles of the hand play a most important part in maintaining this integrity. In extension the fingers spread out like a fan; in flexion they converge toward the palm, the middle finger alone flexing in the line of its metacarpals. The tip of the thumb comes in contact with the other fingers, but faces in an opposite direction. This coördinate converging movement is absolutely essential to the delicate use of the hand and is impossible unless the carpal arch is preserved. In examining cases of paralysis of the interossei from nerve injury the movements of adduction and abduction of the fingers during flexion and extension have frequently been mistaken for true interosseous

movements. The extrinsic extensors can splay the fingers, the long flexors converge them, but no muscle group other than the interossei can move the middle finger from side to side in the plane of the extended hand.

The Thumb and its Relation to the Hand. The thumb is the most important digit of the hand, its functional value exceeding that of the four other fingers. The capsule and synovial cavity of the first carpometacarpal joint are distinct from the other carpometacarpal articulations, and there is no interosseous ligament binding the thumb metacarpal to the index. The saddle-shaped articular facet of the trapezium allows an unusual freedom of motion. Any muscle which acts upon the joint may produce very unusual movements. This is seen in the "trick" movements of the thumb in certain cases of paralysis.

The proper functioning of the thumb is directly dependent on the integrity of the arches of the hand. Any weakness or damage to these arches means an impairment in strength, mobility and fineness of movement.

From a surgical standpoint we can consider the basal element of the first digit as a phalanx. It possesses many of the functional and developmental characteristics of the phalanges, the most noteworthy function being its freedom of motion. Of all the metacarpals it shows the most varied mobility, next comes the fifth, then the fourth, the index possesses but little mobility, while the middle is the most fixed of all. To procure the best functional results in atypical amputations and in certain disabilities following trauma these relative mobilities must be borne in mind. Huguier's operation and similar operations are based on the mobility of the first metacarpus, Baldwin's operation for paralysis of the intrinsic muscles of the thumb on the abolition of this mobility by an arthrodesis of the first carpometacarpal joint.

Note that the thumb at rest lies in a plane almost at right angles to the other fingers. Its palmar surface faces across the hand with a slight axial rotation toward the palmar surface of the index finger. Try and hold your own thumb in the same

plane as the other fingers and see how fatiguing it is, yet we often see a damaged thumb splinted in this unphysiological manner. In fractures of the phalanges the axial rotation must be remembered. Perthes, in his operations for plastic substitution of the thumb, reproduces this axial rotation in the transplanted metacarpal by osteotomy. In the position of grasp the basal metacarpal of the first digit makes an angle of 60 degrees with the index; this is the functioning position for almost all purposes.

Skin Joints, their Function and the Respect Due Them. The crease lines of the palm and fingers are nicely adjusted stasis planes designed to permit the greatest freedom of flexion to the joints of the hand. Great disability can be inflicted on the fingers and tendons by a thoughtless interference with these planes. To damage existing crease lines is bad enough; to create a new stasis line at right angles to the normal creases may inflict a serious functional handicap. Such a condition is often encountered in the fingers. In the excision of scar tissue, in atypical amputations and in the transplantation of skin flaps precautions should be taken to have the suture line follow as far as possible the normal crease lines.

The Preservation of Tendon Slings and the Gliding Mechanism of the Tendon Sheaths. The function of the slings is to hold the tendon in place as it passes over the joint. We have mentioned the disabilities which arises from interference with the normal stasis lines, but these are trivial when compared with those that follow the thoughtless slitting up of a tendon sheath. If it is necessary to incise a sheath the tendon slings should be saved by skipping them.

Treatment. The physiological treatment of the disabilities of the hand is based on a few simple principles, and these can be applied to disabilities which follow sprains, dislocations, fractures, injuries to tendons, injuries to nerves and to the innumerable lesions which follow in the wake of a cellulitis and of trauma.

The outstanding disabilities following these varied pathological

conditions are loss of substance, skin contractures, painful stumps, joint stiffness, adherent tendons, bad functional position, drop-wrist, flat-hand, claw-hand, damaged arches, loss of grasping power, ischemic paralysis.

The functional and anatomical relationships of the structures of the hand are so intimate that it is rare to have but one structure involved in a disability. As a rule, we have to deal with combinations rather than with individual lesions. The most usual association encountered is structural damage, adherent tendons and joint stiffness.

FIG. 1A.—Four months after an infectious arthritis of the carpus. A stiff, useless hand. Note the position of wrist and fingers fixed in extension.

In the operative correction it is obvious that deformity and joint stiffness must be overcome before any serious tendon reconstruction can be undertaken.

Treatment of Stiffness and Deformity of the Wrist. We will take it for granted that the lesions under discussion have received

a thorough course of physiotherapy and that the disability has failed to respond or that the limit of improvement by these means has been reached. We will omit the treatment of Colles'

FIG. 1B.—X-ray showing atrophy of destruction.

fracture and the treatment of fracture and dislocation of the carpal bones with the comment that any disability of the hand or wrist (except Colles' fracture in the first stage of treatment) should be placed in the position of rest.

Always try for a mobile wrist. If failure is inevitable or if ankylosis is thought advisable place the wrist at 30 degrees

Fig. 1C. — Shows the first stage in the treatment of stiffness and deformity of the wrist. The placing of hand and wrist in the position of rest. Later to be followed by wedging according to the Dickson technic, etc., for the deformity of the fingers.

dorsiflexion. With free pronation and suprination this makes a strong, useful wrist (Fig. 1, *A. B. C. D.*). When free rotation is impaired by involvement of the inferior radioulnar joint it can be restored by the removal of a small portion of the ulna (Cotton's operation).

FIG. 1D.—Ten months later. The result of treatment—a strong, powerful grasp.

Treatment of Flat- or Weak Hand. In the simple cases arising from weakness and relaxation much can be done by suitable muscular exercises. In the cases where there is a yielding of the lateral bony supports of the proximal carpal arch, giving rise to weakness and pain, excellent results are obtained by the use of Goldthwait's flat-hand strap; the strap to be worn until the muscles and ligaments have regained their tone (Fig. 2). In the severe cases, with bony displacement, manipulation under an anesthetic plus temporary fixation in plaster may be required. In the cases where a weak and painful hand has developed after

the removal of a metacarpus, or some portion of it, the author has employed a figure-of-eight strap with a supporting palmar pad or a suitable glove reaching to the fingers, which is reinforced to support the transverse metacarpal arch. Heavy manual work involving the use of this portion of the hand can then be successfully undertaken (Fig. 3).

FIG. 2.—Goldthwait's flat hand strap.

Treatment of Fracture of the Metacarpals. The most usual deformity is a shortening and dorsal bowing of the shaft plus a depression of the knuckle. The integrity of the longitudinal arch being impaired, limitation of flexion of the metacarpophalangeal joints results. Such fractures are best treated by traction with a dorsal pad over the shaft and a supporting palmar pad under the head.

We have seen neglected cases of this type simulate closely the claw-hand that occurs in paralysis of the intrinsic muscles of

the hand. The lumbricales and interossei arise from the deep flexor tendons and wind around the proximal phalanx to be inserted into the common dorsal extensor expansion. Their functions are to fix and flex the metacarpophalangeal joints and extend the first and second phalangeal joints. It can be readily seen that in fractures with displacement these tiny muscles, in addition to being injured by the fracture, may be

FIG. 3.—A simple figure-of-eight strap with a palmar pad to support the metacarpal arch, used in cases where the removal or damage of metacarpus has led to a weak and painful hand.

placed at an immense mechanical disadvantage. If they are not protected the stronger common extensor will hyperextend the knuckle and the common flexor will roll up the second and third phalanges. The static condition persisting, an adaptive shortening develops which in turn leads to fibrotic clawing of the hand. This condition is extremely resistent to treatment (Fig. 4).

Treatment of Clawing. The clawing following the paralysis of the small muscles of the hand is a severe disability. If it fails to respond to treatment a useful hand can be obtained by Stile's operation (Fig. 5, *A. B. C.*). In this operation both halves of the sublimis tendon, where it splits to let the profundus pass through, are detached from their insertions and passed to the back of the finger, to be sutured into the extensor comminus

FIG. 4.—Typical case of flat hand with hyperextended metacarpophalangeal joints. This condition is extremely difficult to treat.

tendon distal to the knuckle, thus making an extensor for the interphalangeal joints.

A second method consists in performing an arthrodesis of the metacarpophalangeal joints and placing them in a position of slight flexion.

Thumb. One of the commonest disabilities of the thumb is the adduction-extension deformity. The most frequent causes of

this disability are the skin cicatrices and the fibrous contractures of the deep structures of the first interosseous space that follow

FIG. 5A.- A stiff, useless, clawed right hand, due to damage to the transverse metacarpal arch and partial paralysis of the small muscles of the hand. Condition three months after injury.

burns, trauma and infections; occasionally it is encountered after fractures of the first and second metacarpals; it is the usual sequel to paralysis of the thenar muscles. This deformity is most frequently met with in those cases which have undergone prolonged immobilization in flat board-like splints.

FIG. 5B.—Anatomical result obtained by Stiles' operation.

If corrective splinting and physiotherapy fail much can be done by conservative plastic work. In the treatment of paralysis of the thenar muscles we have the choice of two procedures—an arthrodesis of the carpometacarpal joint or tendon substitution. An example of the former being Baldwin's operation, of the latter, operations of the type of Steindler's or Ney's.

Baldwin's operation for flat adducted thumb deformity is an arthrodesis at the basal thumb-joint to procure a short fibrous union in the functioning position. A short anterior incision is made into the basal joint; the thumb is twisted into the fullest

internal rotation, complete abduction and slight flexion, *e. g.*, the normal position of grasp for the thumb and forefinger. The articular cartilages are cut from the trapezium and the base of the first metacarpus. "The wound is closed and the thumb fixed in the functioning position for three weeks. Fullest abduction and internal rotation of the thumb are absolutely essential."

FIG. 5C.—Functional result three months after Stiles' operation. The patient has returned to work. The hand was treated by plastic repair, and traction of the fingers by Baldwin's splint. The maximum improvement having been obtained by these means, Stiles' operation was then performed.

The pincer action of the thumb is now made possible and this action is valuable in performing the delicate movements; but unfortunately the grip of the thumb is not restored (Fig. 6, *A. B. C.*).

In Steindler's operation for the plastic substitution of the opponens action of the thumb the sheath of the flexor longus pollicis is split and the tendon divided longitudinally; one-half

of the tendon is inserted into the outer side of the base of the first phalanx and sutured to the periosteum. The sheath of the flexor longus pollicis is then closed. This half of the tendon is now running in the direction of the paralyzed opponens pollicis and each flexor movement of the thumb will be accompanied by an opposition movement of the thumb against the fingers.

FIG. 6A.—Baldwin's operation. Flat hand with adducted thumb due to paralysis of the small muscles of the hand. Note the helpless position of the thumb.

Ney's operation is a tendon transplant for paralysis of the intrinsic muscles of the hand. The greatest disability of this condition is the loss of the opposing action of the thumb. To overcome it "the short extensor tendon of the thumb is passed through a tunnel under the anterior annular ligament and transplanted into the tendon of the palmaris longus," or that muscle being absent (about 20 per cent of cases) into the flexor carpi radialis without the division of this latter's tendon.

Treatment of Stiff Metacarpal Joints. Under this head we will take up the cases in which there is no gross bony change but where the flexion of the metacarpal joints have been interfered with by changes in the joint capsule, contracture of the extensor tendons, involvement of these tendons in the scar or a combination of all three. This latter condition is quite common after infection. Stiffness of the metacarpophalangeal joints is always

FIG. 6B.—Baldwin's operation of arthrodesis of basal joint has been performed and the thumb placed in the position of grasp.

a serious disability because without flexion at the metacarpophalangeal joints a good grasp is impossible. The disability is said to be caused by improper splinting. In our experience this is by no means the whole story; we have seen it occur as a sequel in cases of nerve injury and in cases of cellulitis where massage and suitable movements were instituted from the very earliest moment.

FIG. 6C.—Functional result eight weeks after operation.

From an academic standpoint it is interesting to differentiate between tendon shortening and fibrosis of the joint capsule. From the standpoint of treatment it is immaterial to know which is the predominating element.

Dickson has suggested the following simple test: Pressure is applied to the head of the first phalanx until the metacarpal joint is flexed as far as possible; if active flexion of the interphalangeal joint is possible the limitation is due to a stiff carpophalangeal joint. If the interphalangeal joint cannot be passively flexed except when extension of the metacarpal joints takes place, then the condition is one of tendon shortening or tendon involvement.

The treatment of stiff metacarpal joints requires pains, patience, perseverance and time. The four following methods are used in the treatment of this persistent disability: Manipulation under anesthetic with fixation of the fingers in flexion; division of the thickened capsule with fixation of the finger in flexion; traction with gradual flexion; gradual correction by means of plaster.

The permanent results from mobilization under anesthesia are very disappointing. Since the war (1915) we have not employed this method except in a few mild cases where the disability was caused by light adhesions. We have no personal experience with the second, and this method does not appeal to us. In the mild cases we have used the traction and distraction method with success, but in stubborn cases we have obtained our best results by Dickson's method of gradual correction.

In the traction method gradual flexion is carried out while traction is applied to the fingers. The traction is maintained in the line of deformity until separation of the joint surface is obtained. The direction of the traction is then altered and progressively changed as indicated. During the day traction should be omitted for a few short intervals to permit of massage and exercises. The wrist is fixed in a bivalve plaster splint in 30 degrees dorsiflexion. A loop of strong, malleable iron wire

surrounds the finger tips and furnishes the bar to which the traction from the fingers is attached. For this purpose Baldwin has constructed an ingenious adjustable finger-traction splint.

Treatment by Dickson's method of gradual flexion with plaster: "The metacarpal joints are gradually flexed with plaster; then by means of a retaining splint this flexion is maintained between massage treatments until there is full voluntary flexion and no tendency to relapse. The ability to flex the joints voluntarily and retain the flexion is the indication for the removal of the splint." The first step consists in the application of a plaster cast and the cutting of a window to expose the fingers. A general anesthetic is preferable but not a necessity. Under anesthesia light adhesions are broken up and the maximum flexion of the metacarpals obtained. The hand, forearm, elbow and enough of the upper arm to fix the elbow are suitably padded with cotton; excessive padding is to be avoided, otherwise the cast will work loose and slip. The hand is placed in the "cock-up" position and the metacarpals flexed as far as possible. The plaster is then applied to include the hand, forearm, elbow and lower third of the upper arm. The thumb is left free. When the cast becomes hard the portion of its palmar surface over the fingers is cut to allow the tips of the finger to come out. This leaves a plaster cock-up extending half-way up the palm. The second step consists in a gradual flexion of the metacarpophalangeal joints by wedging with felt pads. The felt pads are wedged between the dorsal beak of the splint and the heads of the first phalanges. The metacarpals being fixed in the cast the wedging force flexes the metacarpophalangeal joints and stretches the contracted structures. This force acting on the heads of the phalanges at right angles to the shaft gives the maximum leverage without any tendency to impaction. The pads are fixed with plaster to prevent their removal; the patient is instructed to pull his fingers and thus increase the flexion. The pads become quite loose in a few days and additional wedges have to be applied. This procedure is repeated until the metacarpophalangeal joints are completely flexed; this

takes about four weeks. When the maximum flexion is obtained it is to be retained for a week or ten days. The third step consists in the removal of plaster beak and the employment of a flexion retaining bar. A notched piece of metal to act as a guide for the traction wire is inserted on the palmar surface of the wrist and an anchoring metal ring near the elbow. A padded bar is placed over the head of the phalanges and from the center of this a wire runs over the guide-post to a traction spring, this spring being in turn fixed to the anchoring ring at the elbow. By adjusting this spring sufficient force can be applied to keep the fingers flexed. It is important to see that the bar rides over the head of the phalanges. The bar is removed during massage, etc. This stage of the treatment occupies ten days to two weeks. The fourth step consists in the removal of the original cast and the application of a short cock-up splint, the flexion retaining apparatus being attached to a laced cuff above the elbow.

The cuff and traction straps allow free motion at the elbow while the metacarpophalangeal joints are kept in full flexion. The apparatus is not to be removed until the patient has obtained the power to flex the joints and retains the flexion. Any tendency to relapse is an indication for further splintage. If it should be necessary to obtain flexion of the interphalangeal joints, traction tapes are attached to the fingers and the retaining bar discarded. These traction tapes should never be used until full flexion of the metacarpophalangeal joints are obtained, for if the proximal phalanx is in the extended position the major portion of the force applied will cause impaction. Fig. 7, *A. B. C. D.* shows treatment and results obtained by the Dickson method.

Treatment of Painful Scars. If after a reasonable time no improvement is obtained from physiotherapy, then a thorough excision of all the scar tissue should be carried out. In addition, 1 inch of the cutaneous nerve supply should be excised or the nerve injected with absolute alcohol and the wound closed immediately by suture or by a suitable full thickness pedicle graft.

Treatment of Painful Finger Stumps. This condition seldom occurs in aseptic cases if the proper methods of amputation and

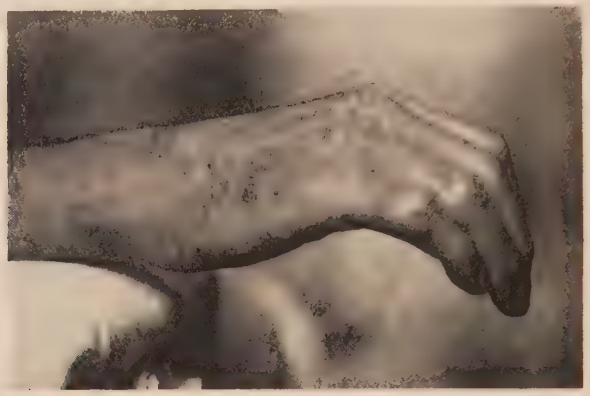

FIG. 7A.—Treatment of stiff metacarpal joints, contracture of extensor tendons, etc., by Dickson method. Condition of hand on admission. The fingers are fixed in the position shown.

FIG. 7B.—Shows palmar aspect of cast cut away and the method of inserting the felt wedges between the beak of the cast and the first phalanges. Complete flexion at the metacarpophalangeal joints has been obtained.

after-treatment are followed. Unfortunately in the finger stumps resulting from laceration and infection, and despite all care, the patient may be left with an exquisitely tender stump;

often the whole finger is involved. The skin in the earlier cases has a bluish-red, glossy, ill-nourished appearance, in the later stages a certain toughness and lack of pliability. The fact that the amount of disability appears to be entirely out of proportion to the lesion has led many men to unjustly accuse these sufferers of malingering; the large majority of these cases have a real pathological basis for their pain and tenderness. "He jests at scars that never felt a wound."

FIG. 7C.—Shows padded traction bar over heads of phalanges, the notched metal guide, the traction wire, spring and anchoring ring.

The studies carried on during the war have thrown much light on this disturbing condition. Foreign bodies or bacteria were found in almost all cases of fibroneuromata. The study of the cicatricial tissue showed that the nerves as well as the surrounding structures were infiltrated with a dense inflammatory tissue. The nerve filaments and the nerves, instead of follow-

ing their recognized anatomical paths, were found to follow various structures; they accompanied the newly formed blood-vessels, worked their way into the tendon sheaths or wandered aimlessly about, crossing and recrossing until they made a veritable network, and all this without apparent rhyme or reason.

FIG. 7D.—Short splint, elbow free, flexion retaining apparatus attached to a laced cuff above the elbow.

Todd has called attention to these findings and concludes that the pain in many of the amputation stumps is due to the generalized inflammatory condition of all the tissues and not of the nerves or nerve-endings only. Any operation for relief of pain or tenderness in such finger stumps will not be wholly successful if a zone of latent infection is entered in the reamputation. With this we heartily agree.

Local operative interference is worse than useless, as it stirs

up trouble and makes things worse. If you cannot amputate through healthy tissue it is better surgery to leave these fingers alone until the pain disappears.

FIG. 7E.—Shows the functional results obtained nine months later.

Treatment of Mutilations of the Hand. Partial amputations of the hand are of infinite variety, frequently atypical and often complicated by contractures and impotent fingers.

We will confine ourselves to a few general principles and take up more in detail the mutilations of the thumb and their plastic repair. In partial amputations of the hand the object is to try and utilize to the best possible advantage those structures which are intact or are capable of being made to function and only to have recourse to a prothesis when it can aid the remaining functioning structures. Good looks and function often go together, but if necessary good looks must be sacrificed to good function, the only criterion of success in the hand being restoration of function.

As the strength of the palm depends on the integrity of the relationship of the metacarpals, it is essential to preserve the heads in all metacarpophalangeal amputations. The unnecessary sacrifice of such an important keystone is hardly justified by the excuse that soft parts are scanty, as a flap can be readily obtained from the chest or abdomen. To sacrifice it for the sake of improving the symmetry of the hand is a serious error. A primary comparison of the symmetry of such hands will be in favor of the hand in which the head has been excised. If the same comparison is made six to eight months later it will be noticed that the atrophy of the bone and surrounding parts will have greatly diminished the gap between the fingers and that the symmetry of the hand compares favorably with the unduly narrow hand. The functional comparison is all in favor of the hand in which the head is retained. The excision of the head, besides resulting in a weak hand, often leads to a tender palm which renders the hand useless.

Mutilation of the thumb is a serious functional handicap, not only in itself but also in its effect on the remaining fingers; the destruction of the thumb destroys the most important arm of the prehensile forceps. From a functional standpoint the thumb is more valuable than four fingers. Its loss is rated by the French as a 25 to 35 per cent disability. The English rate

it as a 30 to 40 per cent disability, considering it the same as the loss of four fingers. The loss of one or more fingers, especially the last three, does not diminish to a great extent the functional value of the hand if it leaves the pincer action of the thumb intact.

A great deal of attention has been focussed on the mutilations of the thumb, especially on the loss of the thumb and its metacarpus. The procedures employed to overcome these serious disabilities can be divided into two groups: To the first group belong the two plastic methods of Nicoladoni (1897–8). These consist of (1) the formation of an opposition finger stump by an autoplastic pedunculated skin flap which contains a free bone graft—this bone graft giving the necessary rigidity and supplying the point of opposition for the pincer action; (2) an autoplastic transplantation of a finger or toe to replace the thumb.

In contrast to this we have a second group of procedures which instead of employing the transplants from a distance utilize the structures at hand to produce a new thumb: To this group belong (1) Huguier's operation (1852) (phalangization or clefting), in which a new thumb is made from the first metacarpus. (2) Finger substitution. (3) Rotation of the remaining fingers: in the complete loss of the thumb; Lauenstein (1880) did an osteotomy of the second and fifth metacarpals and rotated the index and little fingers so that their palmar surfaces faced each other. In this manner the hand was hollowed and a certain amount of grasp obtained. (4) A combination of the above three methods, as performed by Perthes—phalangization, finger transplantation and rotation.

Treatment of Multilations of the Thumb Where the First Metacarpus or a Substantial Portion of it Remains Intact. Such cases are to be treated by Huguier's operation (phalangization) or by Nicoladoni's second method. A short but useful thumb is obtained by Huguier's operation. This new thumb is made from the metacarpus, Huguier taking advantage of the well-known mobility of the first metacarpus, rendered its interior half free by enlarging the first interosseous space.

FIG. 8A.—Huguier's operation. Eight years after mutilation of hand by burns, with total destruction of little finger, partial of the index and total of the thumb, with the exception of a small stump of the first metacarpal.

FIG. 8B.—Plastic repair of the contractures by flaps from the abdomen.

Technic: The incisions will vary with the scar tissue and with the amount of available skin. With the hand prone make a dorsal incision midway between the first and second metacarpals, the upper extremity corresponding to the middle of the

FIG. 8C.—Huguier's operation. Functional result nine months later. Note grasp.

high portion of the interosseous space. This dorsal incision exposes the external border and base of the first interosseous and the dorsal aspect of the metacarpals. Divide the interosseous where it is attached to the bone and reimplant. If present, expose the tendon of the adductor of the thumb,

detach it from its insertion on the first phalanx and reimplant. Suture skin edges from before backward (Fig. 8, *A. B. C.*; Fig. 9, *A. B.*; Fig. 10, *A. B. C. D.*).

FIG. 9A.—Result of Huguier's operation. Formation of a new thumb from stump of first metacarpus. Boy aged nine. Thumb, index, middle and ring fingers blown away by an exploding shell fuse July 20, 1916, Montmacq, Oise, France. He sustained a serious compound comminuted fracture of remaining metacarpals, with extensive laceration of soft parts. Treated by Carrel method. Operation July 30, 1916.

This operation has been modified, in suitable cases, by the excision of the second metacarpus to deepen the cleft and improve the grasp. By this method Perthes produced a useful hand in

a girl who had lost all five fingers. He mobilized the first metacarpus, excised the second and third and performed an osteotomy on the fourth and fifth. By excising the second and third metacarpals he obtained a deep cleft which increased the mobility

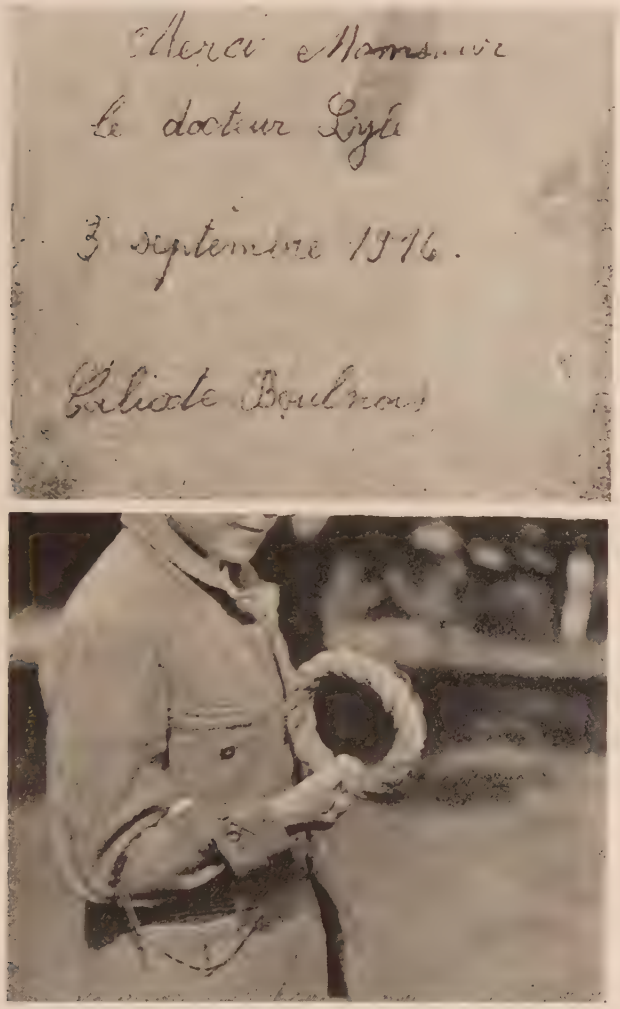

FIG. 9B.—Huguier's operation. Functional result September 3, 1916. Note the writing and the grasp of the new thumb.

of the first metacarpus. By sectioning the fourth and fifth metacarpals he was able to rotate them so that the palmar surface of this portion of the stump faced the new thumb, thus obtaining a better pincer action for the new hand.

FIG. 10A.—Huguier's operation. Formation of new thumb from first metacarpus. *X*-ray of original injury June 6, 1913. Note the damage to the epiphyseal cartilage of the metacarpus.

Nicoladoni, of Graz, after having given up his first method, developed his toe transplantation operation in 1898. He made a new thumb by grafting the second toe to the stump of the first metacarpus. The functional result was only fair, the morphological poor. This principle has now been extended and applied to other fingers and toes. In Nicoladoni's original case, as in a number of others now appearing in the literature, the transplantation was done on the base of a movable metacarpus. The functional results are variable and often hampered or spoiled by the adherence of the flexor tendons. Where the

FIG. 10B.—Condition of hand, showing the formation of a new thumb, July, 1913. Soft tissue has been grafted from abdomen.

mobility of the first metacarpus has been impaired by scar tissue, etc., this operation yields nothing more than an immobile

FIG. 10C.—Huguier's operation. X-ray of hand nine years later. Note that the metacarpus has developed greatly.

opposition member. Under these circumstances the functional results are scarcely better than those obtained by Nicoladoni's first method.

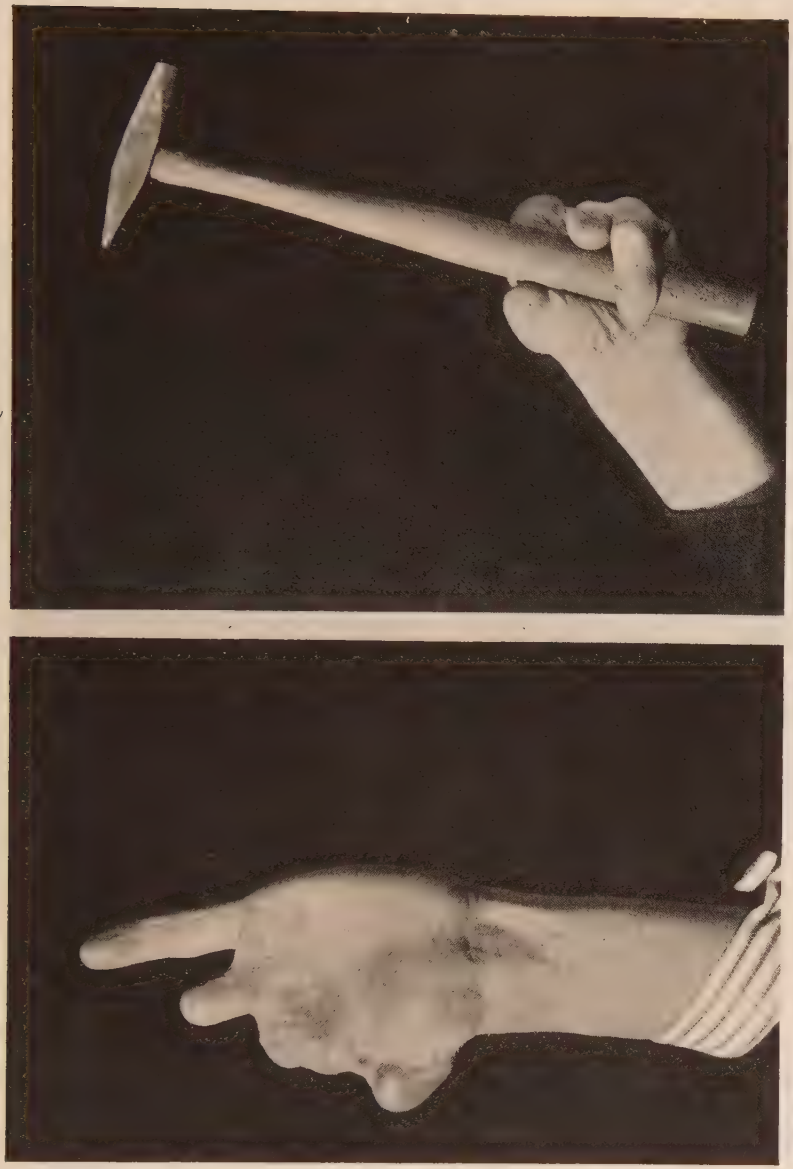

FIG. 10D.—Huguier's operation. Shows result after nine years of functional use. This patient has been driving a taxicab in New York for two years.

Morestin, at the International Surgical Congress, New York, 1914, spoke strongly against this method, considering it next to useless. Some of the results obtained since the War, two of which we have been able to examine, show that the method is of value.

In properly selected cases Huguier's operation yields a better functional result.

FIG. 11A, B.—Perthes' operation for mutilation of thumb, where only small portion of first metacarpal remains. Index metacarpal divided 1 cm. above its base and transplanted to stump of first metacarpus. It was rotated 90° and sutured in the position of grasp. A strong, useful hand was obtained. (See Perthes.)

Treatment of Mutilations of the Thumb Where Only a Small Portion of the First Metacarpus Remains. Perthes reports a case in which the thumb, with the exception of a small stump of metacarpus and the index finger, was destroyed. He divided

the second metacarpus 1 cm. above its base and transplanted it into the stump of the first metacarpus. Before securing it in place he rotated the transplanted second metacarpus 90 degrees, so that the palmar surface faced the remaining fingers. The result was a strong, useful hand (Fig. 11, *A. B.*).

Treatment for Total Loss of the Thumb. Joyce (1917) substituted the ring finger of the opposite hand for the thumb and produced a useful functionating member. Joyce suggests "that by suitable modifications in the details of this operation any lost part of a thumb can be similarly replaced by substituting for it a part of the finger of the opposite hand."

For the total loss of the thumb, Perthes has developed a procedure which appears to give good functional results. It is a combination of the methods employed in adjacent transplantations: (1) A new cleft is formed between the index metacarpus and the third. (2) The index metacarpus is transplanted to the trapezium to take the place of the thumb. (3) The index finger, as in the Lauenstein method, is rotated so that its palmar surface is in the normal position of grasp and fixed in this position (Fig. 12). If this cannot be obtained by modeling the index metacarpus to the saddle-shaped surface of the trapezium then an osteotomy with 90 degrees rotation must be performed on the transplanted metacarpus. In carrying out this method care should be taken to avoid any unnecessary damage to the intrinsic muscle of the hand. If any tendons of the thumb can be salvaged from the stump these tendons should be secured to the metacarpus or fastened to the appropriate tendons of the new thumb. With the new thumb rotated into the position of grasp the flexor tendons act as abductors of the thumb and the extensors as adductors.

Treatment of Mutilations of the Hand Where the Thumb Alone Remains. The problem is to produce an opposition member. If any metacarpals are present this can be done either by cleft-ing or by transplantation of a toe or a finger or by a free-bone transplant. In a case where the thumb was intact and the four other fingers and metacarpals missing, Albee synthetically

grafted a stationary finger by the Italian method. The bone for the necessary rigidity was obtained by free graft from the

FIG. 12A, B, C.—Shows the result of Perthes' operation for total loss of thumb. A new cleft is formed between the index metacarpus and the third metacarpus. The index metacarpus is transplanted to trapezium to take the place of the thumb. Note the rotation of the transplanted index. (See Perthes.)

tibia. This wedge-shaped bone graft being driven into a mortise in the os magnum made a stationary but strong opposing member.

Summary. "The dense, cold, stiff fingers with smooth bluish-red skin that are left after the storm of infection has passed are poor material for any reconstructive surgery." The lesions we encounter, as a rule, involve several structures and their treatment often calls for different procedures at different stages. When to interfere surgically requires judgment, knowledge and experience.

The maximum nutritional and functional improvement should be obtained by conservative means before embarking on any difficult or extensive reconstructive surgery.

The treatment of many of these cases extends through a long period of time and we must keep in mind Hunter's famous teaching, that the power to heal is the property of living tissue, but the power to recover function—the function of muscles and joints—is the property of the patient's will and brain. It is our duty to direct, encourage and interest the will and brain. Keith has aptly said, "We must not make the mistake of supposing that elaborate batteries, gymnastic machines, etc., can take the place of the thinking brain of the surgeon and the willing response of the disabled patient." In other words, good surgeons, like great artists, must mix their paint with brains.

References

Albee, F.: Orthopedic and Reconstruction Surgery, Philadelphia, 1919, Saunders Co., p. 1015.

Albee, F.: Synthetic Transplantation of Tissue to Form a New Finger, with Restoration of the Function of the Hand, Ann. Surg., 1919, lxix, 379.

Baldwin, W.: Orthopædic Surgery of the Hand and Wrist, Jones, Sir R., Orthopædic Surgery of War Injuries, London, 1921, Henry Froude, Oxford University Publications, i, p. 277.

Bunnell, S.: Repair of Tendons in the Fingers and Description of Two New Instruments, Surg., Gynec. and Obst., 1918, xxvi, 103.

Cochrane, W. A.: Disabilities of the Hand and Wrist, Edinburgh Med. Jour., September 22, new series, No. 3, xxix, 96–108.

Cotton, F. J. Sawyer: Stiff Fingers, Boston Med. and Surg. Jour., 1922,

Dickson, J. A.: The Treatment of Stiff Metacarpophalangeal Joints Where There is No Gross Bony Alteration, British Jour. Surg., 1920–21, viii, 272–277.

Goldthwait, J.: Flat-hand (Manus Planus); Its Correction Essential to Normal Function of the Hand, Jour. Bone and Joint Surg., 1922, No. 3, iv, 269–480.

Huguier: Arch. gén. de méd., 1874, i, 78.

Jones, F. W.: The Principles of Anatomy as Seen in the Hand, Philadelphia, 1920, P. Blakiston's Son & Co.

Knavel, A. B.: Infections of the Hand, Philadelphia, 1921, 4th ed., Lea & Febiger.

Keith, A.: Menders of the Maimed, London, 1919, Henry Froude, Oxford University Publications, p. 17.

Lenormant, C.: Le traitement des mutilations des doigts et en particuleur du pouce par les autoplastics et transplantations, La Presse méd., 1920, p. 223.

Lyle, H. H. M.: The Formation of a New Thumb by Klapp's Method, Ann. Surg., 1914, lix, 767.

Lyle, H. H. M.: Amputations, Johnson's Operative Therapeutics, New York, 1915, vol. ii, chap. VI, 295–300, Appleton.

Lyle, H. H. M.: The Physiological Treatment of Bullet and Shell Wounds of the Peripheral Nerve Trunks, Surg., Gynec. and Obst., 1916, xxii, 127.

Lyle, H. H. M.: Deformity of the Hand; Formation of a New Thumb from the Stump of the First Metacarpus, Trans. New York Surg. Soc., Ann. Surg., 1921, lxxiv, 120.

Lyle, H. H. M.: The Formation of a Thumb from the First Metacarpus; Treatment of Hand Contracture, Trans. New York Surg. Soc., Ann. Surg., 1922, xxvi, 121.

Mayer, Leo.: The Physiological Method of Tendon Transplantation, Surg., Gynec., and Obst., 1916, xii, 182.

Mayer, Leo: The Orthopedic Surgeon and Industrial Accidents, Jour. Am. Med. Assn., 1919, lxxiii, 1518–1521.

Nicoladoni: Wien klin. Wchnschr., 1897, p. 663.

Nicoladoni: Daumenplastik und organischer Ersatz der Finger Spritze (Anticheiroplastik u. Daktyloplastik), Arch. f. klin. Chir., 1900, lxi, 600.

Nicoladoni: Weitere Erfahrungen über Daumenplastik, Arch. f. Klin. Chir., 1900, lxv, 695.

Ney, K. W.: A Tendon Transplant for Intrinsic Hand-muscle Paralysis, Surg., Gynec. and Obst., 1921, xxxiii, 348.

Perthes, V.: Ueber plastischen Daumenersatz insbesondre bei Verlust des ganzen Daumenstrahles, Arch. f. Orthopäd. u. Unfallchir., 1921, xix, 198.

Roberts, J. B.: Salvage of the Hand by Reparative Surgery, Ann. Surg., 1919, lxx, 627.

Steindler, A.: Orthopedic Reconstruction Work on the Hand and the Forearm, 1918, New York Med. Jour.

Stiles, Sir H. J., and Forrester Brown: Treatment of Injuries of the Peripheral Spinal Nerves, London, 1922, Henry Froude, Oxford University Publications, pp. 167–171.

Lewis, D., Haber, C.: Amputation Neuromas: Their Development and Prevention, Arch. Surg., July, 1920, No. 1, i, 85.

TUBERCULOUS TENOSYNOVITIS OF THE HAND: A REPORT OF FOURTEEN CASES OF TUBERCULOUS TENOSYNOVITIS

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The accompanying report of 14 patients with tuberculosis of the tendon sheaths of the hand, who have been under my care during the past few years, serves to emphasize the necessity for early recognition of this condition and the possibility of complete cure by adequate and properly directed treatment. The necessity for early recognition is emphasized by the fact that fragmentation of one or more tendons was present in 6 out of 14 patients, secondary involvement of the wrist in 2, and osteomyelitis of the index finger in 1. These complications, in my judgment, were secondary to the tendon-sheath involvement. The possibility of complete cure is attested by the results presented in several patients observed over a number of years.

Etiology. The ages of these 14 patients varied from nineteen to sixty; 1 was fifty-one, another forty-two and 11 were in the third decade of life. The 4 with tuberculosis of the dorsal sheaths were twenty-one, twenty-six, twenty-seven and twenty-eight years respectively. While no age is exempt, the disease shows a predilection for the early years of adult life.

The influence of trauma as an etiological factor cannot be denied, although specific instances may be lacking. One of my patients was a shoemaker, another an artisan who constantly handled tools and another a mail clerk. That trauma is a dominant factor is improbable, since in 4 patients the lesion

involved only the dorsal tendons; but it is doubtless more than a coincidence that in all but 1 case the right hand was involved and the single case of involvement of the left hand occurred in a left-handed individual. Similar observations concerning the hand involved have been made by other writers.

The possibility of infection entering through the skin of the hand itself is suggested by the sequence of events in the following case: In this instance the patient first noticed a small nodule on the thumb, which he himself picked off. Removal of this nodule was followed by a discharge of pus. After the infected area was incised it remained healed for a time; but in a month the discharge reappeared and continued intermittently for about a year, when the patient noticed that the wrist was swollen. Not until then did he come for operation. In this particular case it cannot be denied that the tuberculous process may have been present in the tendon sheath previous to the appearance of the nodule on the thumb.

In only 1 of my patients was there a demonstrable lesion in the lungs, and none had evidences of tuberculosis elsewhere. I am informed, however, that in sanataria for the tuberculous, tubercular disease of the tendon sheaths is not at all uncommon as a complication or sequela of pulmonary tuberculosis. That it is frequently present without an evident lung involvement is certain.

Pathology. Our knowledge of the disease dates from observation of a patient recorded in 1756 by Olaf Acrel, of Stockholm. This report was followed by others from Dupuytren, Velpeau, Laennec, Cloquet and later by observations from German writers: Heineke, Virchow, Brodie and others. One of the earliest comprehensive studies was made by Michon, who apparently recognized the tuberculous nature of the disease; but it remained for Hoeftmann to demonstrate the presence of giant cells and tubercles.

The disease may appear in various forms. In the simplest type a serous exudate alone is present. Later, granulation tissue and rice bodies appear, and finally, in the severest form,

fungous formation and extensive necrosis take place. These variations are doubtless due to the duration of the disease, the varying resistance of the individual and the varying toxicity of the organism. In my own patients all of these variations in pathology have been observed.

The affected area, whether it involves the dorsal or volar surface of the forearm, the wrist, the palmar surface of the hand or the individual fingers, appears as a more or less spindle-shaped swelling. This swelling may give a definite sense of fluctuation; it may be doughy; it is rarely hard and firm. Early in the course of the disease it may be so ill-defined as to leave a question as to its actual presence.

On incising the skin over the affected area the deep fascia appears more tense than normally, and the fascia and superficial tissues may appear slightly edematous. On incising the deep fascia, evidence of pathological change immediately appears. The tendon sheaths are no longer white and glistening, but yellowish-white, grayish-red, gray, purple or bluish-purple. Instead of herniating quickly through the smallest opening in the deep fascia, the edematous tissue tends to herniate into the wound only when an incision of some length is made. On incising it this edematous tissue is found to consist of the thickened tendon sheaths and tendons, more or less closely matted together. If the process is not far advanced it is possible to separate the individual tendons from one another. Then it may be seen that the involved tendons, with their sheaths, form a fusiform enlargement. The sheath varies in thickness from 0.5 to 3 mm., depending on the duration of the disease. On incising the sheath the thickened tendon appears within it. Much of the fusiform enlargement disappears as thin straw-colored fluid pours from the open sheath. The thickened tendon is still free in the sheath, and on incising the tendon it is found that the thickening is due to involvement of the visceral layer of its sheath. The white fibrous tendon is still intact within the soft, vascular granulation tissue which has replaced the normal tissue paper, visceral layer of the tendon sheath. During this stage

the tendon can still be dissected out of the tuberculous sheath and shows little or no pathological change. This is the earliest stage of the so-called hygromatous form.

In a later stage the sheath becomes partially obliterated by fibrous-tissue formation. Fluid is confined to a definite portion of the sheath and rice bodies may appear in the fluid.

Still later the fluid is replaced by a caseous substance which may be localized in one or two areas. The tendon sheath is replaced by granulation tissue and later by fibrous tissue; fragmentation of the tendons takes place, and several tendons, or all of them, may be firmly bound together in a mass of fibrous tissue.

The description of the findings at operation in 2 of our cases is very characteristic. In the first case (C., Wesley Memorial Hospital, No. 86,002) the report is as follows: "The tendons looked bluish, distended and much thickened. On opening the tendon sheaths the apparent enlargement was seen to be due to a homogeneous mass of granulation tissue, which in places seemed to be breaking down and to look caseous. This tissue surrounded the individual tendons like a sheath." In another case (S., Wesley Memorial Hospital, No. 103,348) the report states: "The tendons of the four fingers were involved from a point 2 inches above the volar carpal ligament to the webs of the fingers. In the distal half of the palm, a little to the ulnar side of the midline, was a definitely encapsulated mass, the size of a small egg, filled with sago-like substance, but without fluid and without melon seeds. To the wall of this mass the tendons of the third and fourth fingers were firmly adherent. All traces of the tendon sheaths of the four fingers had disappeared and the isolation of the individual tendons from the fibrous tissue which bound them together was extremely difficult."

These varying conditions, described as characteristic of different stages of the disease, may at times be seen in the same individual. Straw-colored fluid with rice bodies may be present in the radial and ulnar bursæ, while the tendons of the fifth finger in the palm have undergone almost complete fragmentation and

division. Such fragmentation can occur while the tendon still moves freely in its sheath.

The final stage of the uncomplicated disease, the fungous form, is characterized by extensive formation of granulation tissue and caseation, with or without rice bodies. The exposed tuberculous mass is very vascular, soft and of a grayish-red or purple color. It looks like a sausage-shaped enlargement which has replaced the tendinous mass. When the soft, thick, granulation tissue forming its outer wall is incised the interior of the tendon sheath with the involved tendon is exposed. There may be some thick, gelatinous, straw-colored fluid present; there may be rice bodies; there may be only caseous material within the synovial space. At times the swelling may be bilocular, with rice bodies present in one loculus and gelatinous fluid in another. The lining membrane of the tendon sheath is no longer glossy and shining, but dull and lusterless. It may be adherent to the tendon in a part of its course; it frequently shows areas of caseation and necrosis.

The visceral layer of the sheath is involved like the parietal layer. The extent of involvement of the tendon contained within it depends on the duration of the disease. Fragmentation and division of the tendons are the ultimate result. Union of several or all the tendons in a thick mass of scar tissue represents Nature's attempt at cure. It was this particular type of tuberculous disease which led both Lisfranc and Chassaignac to make a diagnosis of sarcoma in lesions which Michon later showed to be tuberculous.

Eventually, if healing by fibrous-tissue formation fails to limit the pathological process, extensive caseation takes place, the involved tissues break down, sinuses are formed and finally a secondary infection is superimposed on the tuberculous process.

Any of the individual tendon sheaths may be involved, but multiple involvement seems to be more common on the dorsum than in the palm. The palmar involvement follows strictly upon anatomical lines, so that we may have isolated involvement

of the tendon sheaths of the index, middle and ring fingers; but if the process involves the little finger or thumb primarily, both ulnar and radial bursæ are involved in nearly every case. An ulnar bursal infection is practically always followed by extension to the radial bursa, and the converse is also true, and in both instances the extension of the bursæ above the wrist shows involvement. When the melon seeds rupture into the forearm they are always found lying upon the pronator quadratus and the interosseous septum, under cover of the flexor profundus digitorum. In 1 of my patients there was involvement of the ulnar and radial bursæ with simultaneous involvement of the tendon sheath of the ring finger, and in another patient a tuberculosis of the tendon sheath of the index finger developed six years after operation for a tuberculous process involving the ulnar and radial bursæ. During the six years there was no clinical evidence of a tuberculous process in the index finger.

Upon the dorsum multiple-sheath involvement is more common.

It is an interesting observation that while there was often fragmentation of tendons—in 6 out of 14 patients—in only 1 case were the tendons of more than one finger destroyed. In 1 case the tendons of the index finger were involved, in 2 those of the little finger; in a fourth case the flexor longus pollicis was involved and in the fifth case the extensor longus pollicis. In our last case a definitely encapsulated mass had formed in the palm, to the wall of which the fragmented tendons of the third, fourth and fifth fingers were adherent. In ulnar bursal infection destruction of the tendons of the little finger is most common.

Attention should be drawn particularly to the involvement of the median nerve in ulnar and radial bursa tuberculosis. The anatomical relations of the nerve in the forearm, at the wrist and distal to it are such that it must inevitably be involved in the process. While in my cases it has always been surrounded by the tuberculous mass, in no case has there been destruction of the nerve, although it is frequently swollen and hyperemic.

Tuberculous tenosynovitis does not tend to become generalized

or to involve the regional lymph glands, although one of my patients presented a tuberculous focus on the skin of the forearm of the elbow. Either the hygromatous or the fungoid form

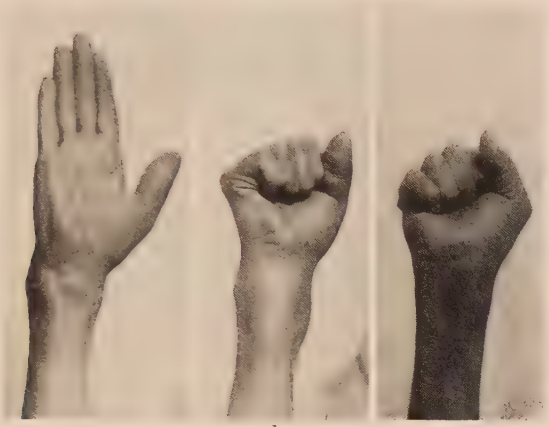

FIG. 1.—Tuberculous tenosynovitis of ulnar and radial bursæ, *a*, *b;* with perfect functional result after operation, *c*.

FIG. 2.—Hygromatous form of tuberculous tenosynovitis, with melon seeds. (From patient in Fig. 1.)

may extend to the surface or to joints and produce typical skin and joint lesions with fistulæ. Cold abscesses seldom if ever appear, but following the formation of fistulæ acute inflammatory processes may develop, with all the serious consequences that follow suppurative tenosynovitis. Rupture of the hygromatous sheath into the forearm with the extension of rice bodies under the flexor profundus often occurs, while less often there may be a rupture into the middle palmar space, as was shown in one of my patients (Y., Wesley Memorial Hospital, No. 37,802).

The histological picture is that of tuberculous tissue elsewhere, with much endothelial proliferation, with an irregular connective-tissue ground substance, interspersed with giant cells in its deeper layers, with tubercles and with coagulation necrosis. The involved tendons as well show giant cells in many places.

During the earlier years great controversy raged over the origin of the rice bodies and melon seeds, which had been compared by Acrel to cooked sago. Dupuytren was the first to call attention to the central cavity that is often found in these bodies. He believed them to be hydatid cysts and to contain parasites. Laennec, Hipp, Cloquet, and the parasitologist, Chiajie, concurred in this theory, so that the disease became known as Dupuytren's hydatid tumor. The majority of observers believed the rice bodies to be unorganized concretions arising from the coagulation of the fibrin in the synovial fluid of the tendon sheaths. Velpeau called attention to the presence of similar bodies in joints and mucous bursæ, and believed they were developed from fibrin, lymph and some from pus. Hyrtl, in 1842, described a case in which rice bodies seemed to be necrotic portions of the tendon sheath wall. After Michon (1851) called attention to the organized nature of these bodies, Virchow suggested that they originated from the coagulation of an albuminous substance, and was seconded in this theory by Heinecke, Brodie, Beger and Koenig. Better staining methods and further study demonstrated that they have their origin in the degeneration products of the tuberculous granulation tissue

and contain in addition accretions from the fibrin deposit. The exact origin of the rice bodies is an academic question, but the

a *b* *c*

FIG. 3.—Tuberculous tenosynovitis of ulnar and radial bursæ, with plastic repair of the tendons. *a*, before; *b*, immediately after; *c*, two years after operation.

fact that their presence is pathognomonic of tuberculosis is of importance, although isolated cases are reported in which tuberculosis has not been demonstrated.

The histological picture of a rice body presents chiefly fibrinous material, which contains here and there a giant cell with the Bacillus tuberculosis. Goldman and Garré showed that these bacilli are capable of producing tuberculosis in a guinea-pig if the rice bodies are implanted in the peritoneal cavity, although not all the bodies contain bacilli.

Symptomatology. In general the symptoms and signs are those of a slowly developing enlargement of the involved area, with impairment of function of the tendons and of the median nerve. At first the patient complains only of a stiffness of the hand, an inability "to make a fist." There may be no history of spontaneous pain. At certain stages of the disease a leathery crepitation may be felt and heard on movement of the tendons, but this soon disappears and is generally not elicited when the patient presents himself for treatment.

The swelling follows the anatomical outline of the sheath involved. In the case of the ulnar and radial bursæ there is a fulness at the base of the palm, more marked upon the ulnar side. Above the annular ligament the lower part of the volar surface of the forearm is enlarged. If the two hands are held up side by side and observed from the lateral aspect the relatively greater thickeness of the affected arm is clearly seen. Pressure above the wrist will cause the palmar swelling to become more tense.

Owing to the involvement of the median nerve the patient not infrequently complains of numbness and tingling, particularly on the sides of the index, middle and ring fingers and often impairment of sensation can be demonstrated. One might expect that the congestion of the nerve would give rise to much pain, particularly in the early stages; but this complaint has not always been present. In one case, however, the character of the pain and its course were so typical of what one would expect that the history with reference to this symptom is taken from the

intern's record (R., Wesley Memorial Hospital, No. 92,841): "About three years ago, as far as the patient can remember, he

a *b* *c*

FIG. 4.—Tuberculous tenosynovitis of ulnar and radial bursæ. *a*, before; *b*, *c*, after operation.

lifted something and noticed some slight pain in this wrist-joint. About twelve hours later the pain became very severe

FIG. 5.—Fungoid form of tuberculous tenosynovitis.

and a swelling appeared over the flexor surface of the wrist-joint and, to a slighter degree, over the thumb. During the

succeeding weeks the swelling fluctuated in size, but a dull pain was constantly present and was aggravated by motion. The pain was seemingly worse at night and for six months the patient would get up two or three times at night, unable to sleep on account of the excruciating pain. About three weeks after the onset he noticed a numb feeling over the middle and ring fingers and a stiffness in his joints. For the past two years there has been comparatively no pain."

In our last case the history dates back seven years. The patient first noticed a swelling about the ulnar side of the wrist, and pain which extended up the forearm and down the fingers. This pain was described as a "terrible burning," so that the patient frequently got up at night to plunge her hand and forearm into ice-cold water. She sought one doctor after another and applied lotions, ointments and packs without affecting the pain in any appreciable degree. A year after the onset the severity of the pain diminished very markedly and for the past six years there has been little spontaneous pain. Another patient, whose history extended over a period of eighteen months, stated that for the first six months she had severe burning pain throughout the hand and forearm, particularly at night, and when the hand was elevated. She hung the arm over the side of the bed to relieve the pain, and frequently got up at night to plunge it into a reservoir of hot water which stood at the back of the kitchen stove.

When rupture of the melon seeds from the ulnar bursa into the palm has taken place the middle palmar space is involved and the concavity of the palm is lost. When the rupture has occurred into the forearm a general swelling of the entire flexor part of the lower half of the forearm is noted. Even before fragmentation of the tendons occurs there is partial loss of function of the fingers involved. Stiffness, swelling, the inability to flex or extend the fingers completely are the earlier symptoms. Loss of power and finally inability to move the fingers indicate extensive involvement of the tendons.

When the tendon sheaths on the dorsum are involved the

patient complains of little except stiffness and a fluctuating swelling over the anatomical outline of the sheaths. There is

FIG. 6.—Tuberculous tenosynovitis of index finger, secondary to tuberculous tenosynovitis of ulnar and radial bursæ, successfully operated upon six years previously.

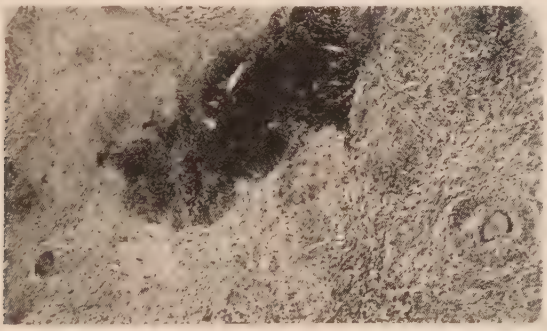

FIG. 7.—Cross-section of tendon removed from patient in Fig. 6, showing characteristic tubercle formation.

little limitation of motion and little or no pain and tenderness. Crepitation may be felt at certain stages of the disease.

In old, neglected cases and those with bone and joint involve-

ment, fistulas form, secondary infection ensues and the typical well-known picture of joint and bone tuberculosis is presented.

Systemic symptoms are so slight as to be of no importance, but other foci of tuberculosis should always be sought.

TREATMENT. Tuberculosis of the tendon sheaths, if unaccompanied by active lesions elsewhere, is probably one of the least difficult of tuberculous processes in which to obtain complete cure. This may be secured either by conservative treatment, such as removal of the melon seeds, injection of iodoform emulsion and immobilization by splinting for a considerable period, or by complete surgical removal. The former method requires considerable time for its application, with consequent loss of use of the hand. As a result of prolonged immobilization, atrophy and contractures of the muscles take place, fibrous adhesions form about the joints and these conditions are accentuated by the temporary loss of nerve function and by the involvement of the nerves in the pathological process itself. These results, however, are usually transitory and function is restored some weeks or months after removal of the splints. It may be advisable to combine active surgical intervention and immobilization in advanced cases if the bones and joints are involved in the process.

In my earlier cases the first method was utilized, but in later years the results obtained by complete dissection have been so excellent, both as regards eradication of the disease and the prompt restoration of function, that this method has been used exclusively. I have several patients treated some years ago by the conservative method in whom good results were obtained, but the records are inadequate and I have not been able to get them to return for a verification of the result, so that, with one exception, these are not included in the present report. The exception is that of a patient (Y., Wesley Memorial Hospital, No. 37,802) who was first observed in 1912. He was suffering from tuberculosis of the ulnar and radial bursæ with extension into the palmar space and the forearm, with several tuberculous sinuses, and with probable involvement of the wrist-joint.

a *b*

FIG. 8.—Tuberculous tenosynovitis of the dorsal tendon sheaths of the left hand and wrist, *a*; the right hand and wrist, *b*, are normal.

FIG. 9.—Tuberculous tenosynovitis of the dorsal tendon sheaths.

Short incisions were made in the palm and in the forearm, the melon seeds present were evacuated and an injection of 10 per cent iodoform emulsion made. Splints were applied for a number of months. Meanwhile iodoform emulsion was injected into the sinuses from time to time and tuberculin was administered. After about a year the process seemed to have been entirely eradicated and he began to use his hand. Three years later he came under the care of another surgeon, with a recurrence at the wrist. Splints were reapplied for six months, and since the expiration of that time he has been entirely well except for some limitation of motion at the wrist-joint. He was examined in May, 1922, and showed no evidence of active tuberculosis either in the wrist or elsewhere. The severity of the condition when this patient first came under our care and the long period during which he has been under observation show conclusively the possibility of cure by conservative methods. This fact is confirmed by others and by my own experience in other cases that I have not been able to follow so closely.

I have not included in this critical survey 2 patients with tuberculosis of the dorsal tendon sheaths in which the process was in the incipient stage and in which immobilization was resorted to without other procedures—a method which would seem entirely justifiable in early cases or in those patients suffering from active tuberculosis of the lungs.

Thirteen of the patients used for study in this contribution were treated by active surgical intervention. For study these should be divided into tuberculosis of the sheaths of the flexor tendons and of the dorsal tendons. This division is necessary, since the technic of treatment is different, and in my hands, unfortunately, the results have not been similar.

Surgical Treatment. The operation is always done under local anesthesia—0.5 per cent novocaine is injected above the clavicle so as to block the brachial plexus. If nerve-blocking is not entirely satisfactory it is supplemented by infiltration of the ulnar nerve at the elbow and at the site of incision, and by infiltration of the median nerve after its exposure in the wound.

After the hand is surgically prepared a rubber glove is drawn over it and the glove incised at the site of operation. A bloodless field is secured by maintaining constriction with a blood-pressure apparatus at twenty points above the systolic blood-pressure. The constriction is released at the end of an hour and restored later if necessary; but if the dissection is done carefully it is usually possible to complete the operation without renewing the constriction.

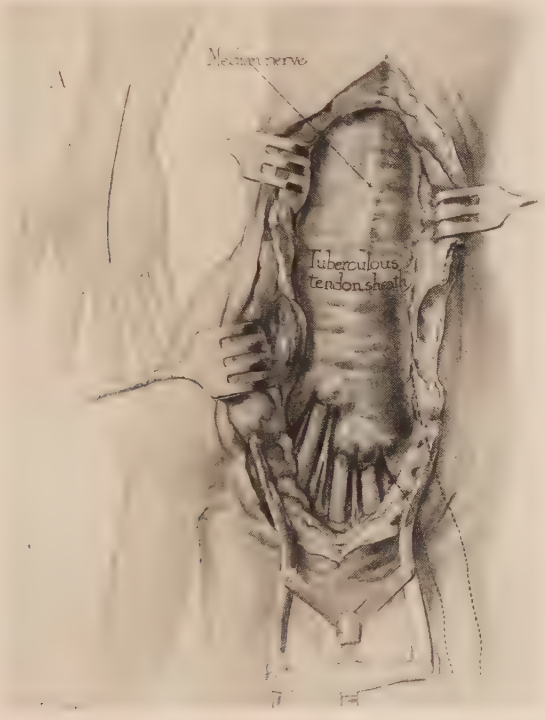

FIG. 10.—Operative incision and appearance of tuberculous tendon sheaths.

By regulating the degree of constriction with the blood-pressure apparatus and maintaining as low a pressure as is consistent with hemostasis the danger of producing a musculospiral paralysis from excessive tension is avoided.

Nine patients with tuberculosis of the flexor tendon sheaths have been subjected to a complete resection of the tuberculous tissue with restoration of function in every case. In the early cases the dissection was supplemented by splint immobilization for varying lengths of time. This period has been gradually shortened until now immobilization is not considered necessary except in those patients who may be suffering from a complication of the disease, such as bone or joint involvement. We realize that the number of patients observed is too small to warrant dogmatic statements, but that permanent and satisfactory results may be obtained without immobilization is shown by the successful results in the patients who have been under our care. The avoidance of the disability due to immobilization is a strong argument in favor of early mobilization.

Since in every case in which the ulnar bursa has been involved there has been involvement of the radial bursa also, the operation should be designed so as to reach both bursæ. The technic used in such cases is as follows:

An incision is made upon the flexor surface of the forearm and hand from 3 inches above the wrist down to the distal flexion crease of the palm. The incision is made over the middle of the forearm and extends into the palm at the radial side of the hypothenar eminence. If the tendon sheath of the little finger is involved farther distalward the incision may be continued to the radial side of the fifth finger as far as necessary, but this extension of the incision is avoided if possible. If the sheath of the flexor longus pollicis, which is directly continuous with the radial bursa, is involved a second incision is made to ensure an adequate exposure. This incision begins a thumb's breadth below the anterior annular ligament, curves radialward around the thenar eminence and extends distalward on the thumb as far as necessary. Such an incision will avoid injury of the motor branch to the muscles of the thenar eminence, a branch given off by the median nerve just below the annular ligament.

The incision on the flexor surface of the forearm and palm is continued through the anterior annular ligament and the palmar

fascia. The ligament is not sutured after the operation, and I have never seen disability result from its incision.

The first structure sought in the forearm is the median nerve. All tuberculous tissue is carefully dissected from the nerve.

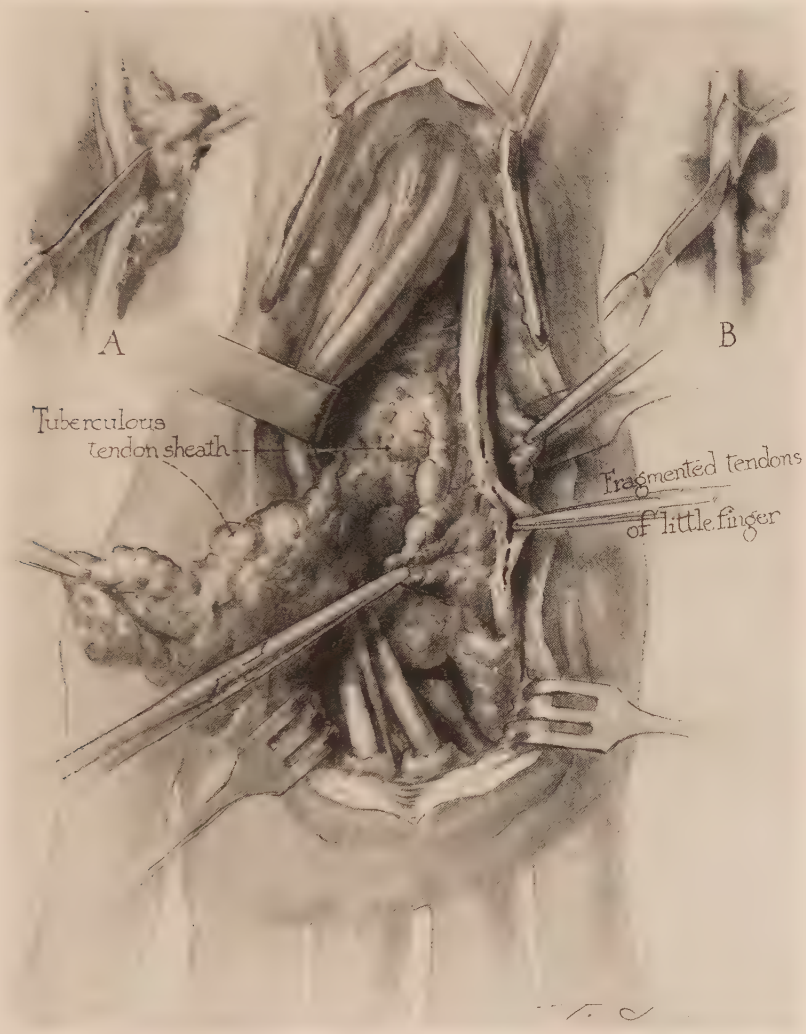

FIG. 11.—Method of dissection of the tuberculous tissue

This is followed into the palm, the greatest care being exercised to preserve every filament. To aid in the dissection it is my custom to use a pair of spectacles which magnify the tissue about one and one-half times. This has the disadvantage of bringing the operator's face closer to the field, but the advantage of enabling him to recognize and preserve the nerve filaments and small bloodvessels. The median nerve is often found completely surrounded by tuberculous tissue, but I have never seen it invaded, although it may be inflamed and swollen to twice its normal size.

When the median nerve has been isolated from the tuberculous tissue and protected by gauze saturated in salt solution the dissection of the tendons and the removal of the tuberculous tissue is carried out. Each tendon is raised in turn and with a fine, sharp knife the thickened visceral sheath is dissected away. One is surprised at how little injury most of the tendons have sustained. Usually the tuberculous sheath may be removed and an apparently intact tendon left behind. As each tendon is freed one holds it aside and passes to the next, the tuberculous tissue meanwhile remaining in one mass or at the most in two.

After the forearm and wrist are thoroughly dissected one passes into the palm and completes the dissection, using redoubled care not to cut any of the nerve filaments and to avoid injury to the bloodvessels as much as possible. The prolongation of the ulnar bursa along the tendons to the little finger requires special attention. If the sheath going to the little finger or thumb is involved (and involvement of either one is common) both layers of the tendon sheaths are completely removed through the incisions described. It is important not to leave the slightest vestige of tuberculous tissue.

Not infrequently one or more tendons may be found fragmented, but the remaining tendons will be found intact. If the destruction has been slight I have left the affected tendons in some instances, but have generally felt it advisable to excise the diseased tendon. If the destruction has been in the palmar

area, and in ulnar and radial bursal tuberculosis that is its customary location, one can secure excellent functional results

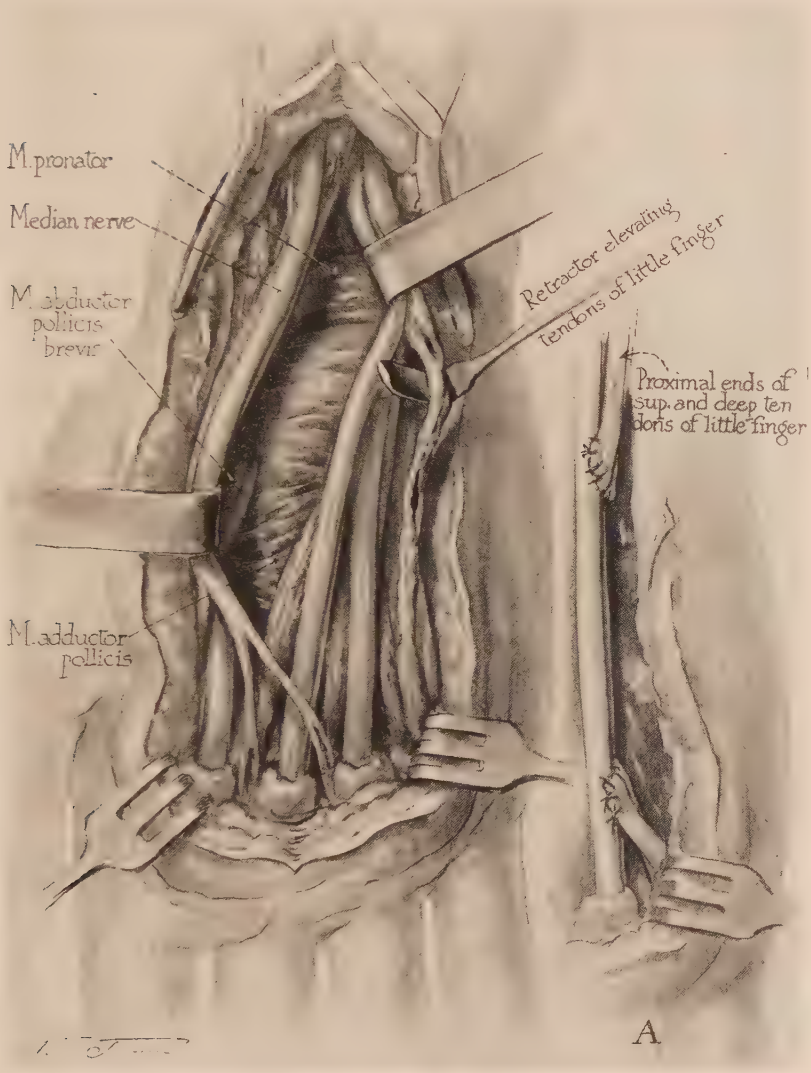
M. pronator
Median nerve
M. abductor pollicis brevis
M. adductor pollicis
Retractor elevating tendons of little finger
Proximal ends of sup. and deep tendons of little finger
A

FIG. 12.—Appearance of tendons after the removal of the tuberculous tissue. *A*, plastic repair of fragmented tendon.

by attaching the severed ends to the corresponding adjacent tendon, care being exercised to attach them at the proper site to secure the same degree of flexion in both fingers. Since the operation is performed under local anesthesia, and since the infiltration of the nerve has begun to lose its effect by this time, it is possible to determine the proper site for attachment by inserting a temporary suture and asking the patient to flex his fingers. Prolonged pressure from the Martin bandage or the blood-pressure apparatus will paralyze the nerve temporarily, so that contraction of the muscles may be impossible; but a proper appreciation of the relative position of the two fingers and of their tendons will enable one to attach the severed tendon at the proper site. The proximal end of each cut tendon is also attached under slight tension to the corresponding adjacent tendon above, thus ensuring some slight degree of individual motion, a result somewhat surprising to me.

All hemorrhage is carefully stopped, and it has been my custom to leave in the wound a small amount of iodoform powder suspended in ether. The incision is closed without drainage. No splint is applied and the patient is told to use the hand for ordinary simple duties as soon as it is healed.

Under this treatment none of these 9 patients has had a recurrence and all have practically complete function of their hands, with the exception of the cases in which the tendon was excised. In these, due to the plastic procedure mentioned, there was very little disability. The photographs presented show the after-result in some of these patients.

In 2 patients, as noted above, tuberculosis was subsequently found in other tendon sheaths. In 1 case (O., Wesley Memorial Hospital, No. 46,977) tuberculosis of the tendon sheath of the index finger was discovered six years after the operation upon the ulnar and radial bursæ. Whether this was present at the time of the primary operation and developed slowly or whether it developed subsequently cannot be said, but it is certain that there was no recurrence in the palm or forearm. This was a particularly favorable case for observation, since the patient

was a shoemaker, and while he refrained for a year from using his hand strenuously, he worked at his trade throughout that time, and during the next five years used it as he had always done, without any attempt to favor it.

The other patient (R., Wesley Memorial Hospital, No. 92,541) returned six weeks after operation with evidence of a tuberculosis of the sheath of the tendons of the ring finger. Here it is certain the lesion was present at the time of the first operation and overlooked. He also had a nodule on the skin of the forearm at the elbow. This was removed at the time of the first operation. He also has remained entirely well to date, a period of over two years.

My experience with tuberculosis of the tendon sheaths of individual fingers is limited to the 2 patients just mentioned. In 1 there was a tuberculosis of the tendon sheath of the ring finger and in the other of the index finger. The former presented the typical proliferation of tuberculous granulation tissue upon both the parietal and visceral surfaces of the sheath, the history stating that this was more extensive upon the superficial than upon the deep tendon. Rice bodies filled the cavity. Under local anesthesia an incision was made upon the flexor surface, from the distal flexion crease of the palm to the distal end of the middle phalanx. The entire sheath was dissected away and the tuberculous tissue dissected from the tendon. Fortunately no fragmentation of the tendons was present. The wound was closed and the patient permitted to use the finger as soon as the primary wound was healed. A complete functional result was obtained, as will be seen by examining the photographs. (No. 92,541, Fig. 1.)

The other patient had suffered for some time with tuberculosis of the tendon sheath of the index finger, and in addition has an involvement of the proximal interphalangeal joint and the distal end of the proximal phalanx. Here it seemed advisable to amputate the finger at the metacarpophalangeal joint and remove the tendons for some distance proximal to this point. An uneventful recovery ensued and there has been no recurrence

of the tuberculosis during the two and a half years that have elapsed since this operation.

These 2 cases typify the procedure to be followed. If there is no involvement of bone or joint, and the tendons are not so fragmented as to demand removal, a complete dissection of the tuberculous material will end in recovery; but if any complications are present, amputation should be the operation of choice.

My experience with cases with tuberculosis of the dorsal tendon sheaths in which adequate records were kept and in which I have been able to follow the results over a fair period of time is confined to 4 patients. Unfortunately it has not been so satisfactory as with tuberculosis of the flexor sheaths. This was due in one case to incomplete excision and in another to poor judgment in the choice of the type of the treatment.

In 2 patients the removal of the tuberculous tissue resulted in permanent cures. In one recurrent case (B., Wesley Memorial Hospital, No. 79,844) the patient at the time of operation was suffering from an incipient pulmonary tuberculosis which was suspected but not proven. Some weeks after operation the pulmonary involvement became evident, and later other sheaths upon the dorsum of the hand became involved or a recurrence took place at the site of the earlier involvement. Personal examination was not possible, but the history obtained seemed to justify this assumption. Upon operation no rice bodies were found; the process seemed to be more acute than usual, and in view of the probability of lung involvement, I believe that the immobilization of the wrist, supplemented by hygienic treatment, would have been preferable.

The other patient (S., Wesley Memorial Hospital, No. 94,649) suffered from a typical tuberculosis of the dorsoradial sheath. Rice bodies had ruptured from the tendon sheaths into the surrounding tissue. Here resection was attempted but was not completely carried out, so that a recurrence with sinus formation ensued. The hand was then treated by sun baths and immobilization, with apparent recovery after nine months.

The history of this patient emphasizes the difficulty of com-

plete dissection of the dorsal sheaths. This can be secured only by the most painstaking endeavor. The sheaths are multiple and pass under the dense posterior annular ligament through separate compartments. These tunnels should be incised and every vestige of tuberculous tissue, including fragmented tendons, should be removed.

It is a pleasure to acknowledge the assistance of my associates, Dr. Sumner Koch and Dr. W. H. Woolston, in following up the patients and verifying the records.

References

Acrel, O.: Chirurgische Vörfälle aus dem Schwedischen. Gallingen, 1777, ii, 183. (Translated by J. A. Murray.)

Beger, A.: Die Tuberkulose der Sehnenscheiden, Deutsch. Ztschr. f. Chir., 1884–5, xxi, 335.

Bille, E.: Ueber das Hygroma proliferum palmare, Inaugural dissertation, Leipzig, 1866.

Chaput, M.: Bull. et mém. Soc. de chir. de Paris, 1908, xxxiv, 23.

Curtis, B. F.: Ann. Surg., 1898, xxviii, 384.

DeQuervain and Lanz: Ueber hämatogene Muskeltuberkulose, Arch. f. klin. Chir., 1893, xlvi, 97.

Dunlap, E. W.: Tuberculosis of Tendons and of Tendon Sheaths, Texas Cour. Rec. Med., 1905, v, 1.

Falkson, R.: Zur Lehre vom Ganglion nebst einem kurzen Anhange über die fungose Sehnenscheidenentzündung, Arch. f. klin. Chir., 1885, xxxii, 58.

Fehde: Ein Fall von Sehnenscheidentuberkulose geheilt durch Landerer'sche Hetolinjektionen, Deutsch. med. Wchn chr., 1905, xxxi, 1035.

Frisch, O.: Ueber Tendovaginitis crepitans, Arch. f. klin. Chir., 1909, lxxxix, 823.

Garré, C.: Die primäre tuberkulöse Sehnenscheidenentzündung, Beitr. z. klin. Chir., 1891, vii, 293.

Gerster, A. G.: Tubercular Synovitis of the Sheath of the Tendons, Med. Rec., 1887, xxi, 277.

Golding-Bird: A Case of Tubercular Tenosynovitis, T. Path. Soc., London, 1888, xl, 244.

Goldmann, E.: Ueber die Bildungsweise der Rei körperschen in tuberkuloserkrankten Gelenken, Schleimbeuteln und Sehnenscheiden, Beitr. z. klin. Chir., 1896, xv, 757.

Grant, Stewart: On Myeloid Tumors of Tendon Sheaths, with Report of a case, Glasgow Med. Jour., 1914, lxxxi, 333.

Hasenknopf, H.: Ueber Sehnenscheidentuberkolose, Inaugural Dissertation, May, 1892.

Hoeftmann, H.: Ueber Ganglien und chronisch fungose Sehnenscheiden-

entzündung (Hygroma proliferum—Virchow), Inaugural Dissertation, Königsberg, 1876.

Hopp, Adolph: Beiträge zur Lehre von den Sehnenscheidenentzündung besonders der chronisch fungosen an der unteren Extremität, Inaugural Dissertation, Berlin, 1886.

Jamin, R.: Synovite tuberculeuse der gaines tendineuses, Progrès méd., Paris, 1882, x, 359.

Kaiser, F.: Zur Kenntnis der primären Muskeltuberkulose, Arch. f. klin. Chir., lxxvii, 1033.

Kaufmann, Max: Ueber die Natur der Corpora Oryzoidea, Inaugural Dissertation, Würzburg, 1886.

König, F.: Die Beduntung des Faserstoffes fuer die pathologisch-anatomische und die klinische Entwicklung der Gelenk- und Sehnenscheiden Tuberkulose, Centralbl. f. Chir., 1886, xiii, 425.

Krechel, H.: Ueber die Reiskörperbildungen in den Hygromen, Inaugural Dissertation, Bonn, 1890.

Landow: Ueber die Bedeutung des Faserstoffes und seine Umwandlungen, Arch. f. klin. Chir., xlviii, 376.

Lucke: Zur Behandlung des chronischen Hydrops der Sehnenscheiden und der Ganglien, Deutsch. Ztschr. f. Chir., 1872, i, 466.

Mayer, M. L.: Ueber maligne Geschwulste der Sehnenscheiden, Inaugural Dissertation, Würzburg, 1886.

Michon, L. M.: Des tumeurs synoviales de la partie inferieure de l'avant bras, de la face palmaire du poignet et de la main, Thésis, 1851.

Muller, G. P.: Tuberculous Tendovaginitis, Ann. Surg., 1912, lvi, 496.

Muller, C. F. Otto: Ueber tuberkulose Sehnenscheidenentzündung, Inaugural Dissertation, 1887.

Murphy, J. B.: Tuberculous Tenosynovitis of the Palmar Synovial Bursa, Surg. Clin., 1916, v, 295.

Nicaise, Poulet and Vaillard: Nature tuberculeuse des hygromas et des synovites tendineuses, Rev. de chir., 1885, v, 609.

Nommel: Drei Fälle von tendovaginitis fungosa an den Fingern, Inaugural Dissertation, 1896.

Schuchardt, K.: Tuberkulose und Syphilis der Sehnenscheiden, Virchows Arch. f. path. Anat., 1894, cxxv, 394.

Schuchardt, K.: Ueber die Reiskörperbildung in Sehnenscheiden und Gelenken Virchows Arch. f. path. Anat., 1888, cxv, 186.

Schiller, K. von: Wegen Sehnenscheidentuberkulose ausgeführte Muskel-. ehnenresekt on, Zentralbl. f. Chir., 1908, xxxv, 503.

Stern, E.: Ueber die Aetiologie und Lokalisation der Sehnenscheidentuberkulose, Inaugural Dissertation, Albert Ludwig's Univ., 1903.

Watson: Multiple Tenosynovitis, Clin. Jour., London, 1912, xli, 83.

Westphal, J.: Ueber Sehnenscheidentuberkulose, Inaugural Dissertation, Kiel 1892.

Willmes, Paul: Histologische Untersuchungen über Sehnenscheidenhygroma, Inaugural Dissertation, Berlin, 1904.

Zoppritz, B.: Ueber die Resultate der Extirpatation des tuberkulosen Sehnen cheidenhygroma der Hand, Beitr. z. klin. Chir. 1903, xxxix, 654.

DISCUSSION

Dr. Willy Meyer, New York:

This is a very interesting subject to me, because I have seen a few cases in which radical extirpation cured this troublesome disease.

I have had 3 such cases under my care, 2 of the dorsal and 1 of the volar side of the hand and forearm. To my mind all these cases should be treated radically. Under general anesthesia and artificial anemia the skin is incised over the entire length of the swelling and the diseased area properly exposed. One has to remember that the tendon sheaths are arranged in the same way as peritoneum and pleura. The visceral portion of the sheaths covering the tendons must not be injured. It appears not to be involved in the disease. The tuberculous parietal portion is extirpated best in one mass. With a little care this can be done and then a good final result achieved.

For the artificial anemia I prefer the use of Sehrt's metallic tourniquet, the type found by Dr. Truesdale in the field hospitals vacated by the German armies on their retreat during the World War. It is a splendid instrument, which, I believe, will not produce nerve injury if used intelligently.

I have always been a great believer in the efficiency of iodoform ether in tuberculosis. Before closing the skin wound I therefore bathe the entire field in iodoform ether, 5 per cent. Then the skin wound is closed completely, of course without drainage, and covered with rubber tissue.

Should aseptic blood clots form inside they are welcome. Arm and hand are then put on a splint and the dressing is not changed for ten or twelve or even fourteen days. After this time I have found the wound healed in every one of my cases. Active and passive motions are soon begun. In my patients the functional result was very good.

Surely this radical extirpation of the tuberculous tendon sheaths cures a most annoying chronic trouble with one stroke and restores the perfect use of the hand.

Dr. M. B. Tinker, Ithaca:

I would like to confirm, from personal experience, the possibility of eradicating tuberculosis of the tendon sheaths, as Dr. Kanavel has suggested. I use practically the same technic: the tourniquet, local anesthesia, sharp dissection of the disease from the tendon sheaths, immediate closure, no splint, and allow the patient to return to work at once.

I was obliged to operate a second time in one instance because of recurrence; for this patient I dissected caseous tuberculous glands from both sides of the neck. He was said to have had pulmonary tuberculosis as well, but remains well as to wrist, neck and lungs, and was working at last accounts as a pilot on one of the smaller lakes in the state of New York.

As regards ability to use his hand, this man plays the flute very well and apparently is entirely unhampered since this operation.

THE IMMUNE MECHANISM IN CANCER

By J. WALTER VAUGHAN, M.D.
AND
HAZEL H. EPPLER
DETROIT, MICH.
(By Invitation)

There is probably no subject of more interest to the medical scientist than that of cancer. This is due partly to the fact that it is one of the common diseases with which mankind is afflicted and in which, so far, science has been completely baffled in its attempts to determine the etiology, as well as because of the helplessness of any method of treatment when the disease has become well established.

Slowly our methods of treatment are becoming of more avail. Surgery sometimes is efficient—radium and deep *x*-ray therapy are aiding the prolongation of life and lessening the suffering in many cases formerly considered as hopeless—but as yet the percentage of recoveries in well-established cancer, by any method of treatment, is not sufficiently great to prove of much satisfaction to those under whose care many cases come.

It is my desire to briefly draw your attention to certain facts that have been established as a result of many years of study of some of the biochemical reactions caused by the introduction of cancer tissue into living animals. These experiments demonstrate quite conclusively why cancer is so difficult to cure when once established, as well as why one case succumbs rapidly to the disease while in another it progresses but slowly.

Some twelve years ago attention was called to the fact that when cancer protein was introduced parenterally into rabbits, guinea-pigs, sheep or man certain definite changes took place

in the circulating blood. This change manifested itself by a definite increase in the percentage of large mononuclear lymphocytes within from twenty-four to forty-eight hours after the introduction of the protein. This increase in large mononu-

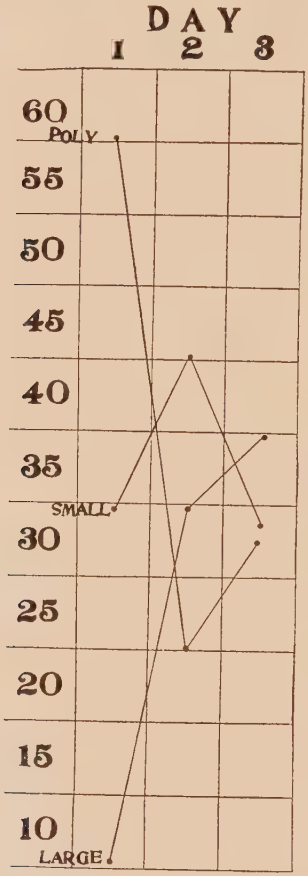

CHART A.—Illustrating blood changes in a rabbit following a single intraperitoneal injection of cells from a breast adeno-carcinoma.

clear lymphocytes is of short duration, lasting but a few hours, after which the percentage rapidly returns to normal.

Usually this increase of large lymphocytes is associated with a decrease in polymorphonuclear cells, and there is a general increase in all mononuclear elements, although the small lympho-

cytes may show a decrease in number as well when the large count is at its height. That this increase in mononuclear cells had a definite relationship to the immune mechanism in malignancy was shown by the fact that animals were killed when large injections of cancer-cell emulsion were given intravenously or intraperitoneally during the short time that the mononuclear increase was at the highest point, while otherwise no apparent effect was noted by the administration of like doses of cancer-cell emulsion. Again, if animals were bled when this lymphocyte count was high, a substance which proved to be in the globulin content of the cell could be isolated from the leukocytes, which, when mixed with cancer cells and incubated, proved to be exceedingly toxic when introduced into a normal animal.

If we are to regard the phenomena of sensitization to a given protein as a measure of the immunity of any given animal to that specific protein, then the phenomena shown above allow but one interpretation—namely, that animals can form antibodies which destroy cancer cells, but that such antibodies are extremely unstable, so that their possession is but a matter of a few hours. How different this is from the immunity conferred when other proteins are administered. Thus, with the typhoid bacillus, immunity once conferred usually lasts several years and may be retained for the duration of life.

For this reason the term transitory immunity has been used to distinguish that particular type, lasting but from four to twenty-four hours, that is elicited when cancer tissue is injected into a healthy animal. Quite obviously it is the explanation of why the body so seldom rids itself of cancer, since if substances are formed to destroy cancer cells and such substances are lost before their work is completed the tumor is given opportunity to grow again before new antibodies are formed.

That some people suffering from this disease are more able to form antibodies than others explains why cancer grows and forms metastases rapidly in some individuals and but slowly in others. Rapid recurrence and death in cancer is not dependent so much upon the type of treatment employed in the attempt to eradicate the disease as it is upon the ability of the person

afflicted to form substances which inhibit the growth of cancer cells. That this is actually the case can be proven by running a long series of blood counts in cases progressing both well and poorly.

As such charts have been published formerly, suffice it to illustrate this point to make mention of the following:

TABLE I.—MEDIASTINAL SARCOMA

Date.	Polymorphonuclear cells.	Large mononuclear cells.	Small mononuclear cells.	Eosinophiles.
June 30, 1910 . . .	87.0	6	6	1.0
July 1, 1910 . . .	80.0	11	6	3.0
uly 27, 1910 . . .	93.0	4	2	1.0
July 29, 1910 . . .	91.5	5	3	0.5

Patient died August 4, 1910.

It can be seen that the lowest polymorphonuclear count taken was 80 per cent while the highest was 93 per cent. In addition the total leukocyte count was greatly increased, varying between 15,000 and 25,000. Daily counts were taken, but only their average, together with the lowest counts, are tabulated. It can thus be seen that the above case is one of rapidly advancing malignancy and the blood findings are confirmative of the clinical course of the disease, the patient having succumbed August 4, 1910.

TABLE II.—BLOOD CHANGES IN A PATIENT WITH INOPERABLE CARCINOMA OF THE LEFT BREAST WITH LIVER METASTASIS

Date.	Polymorphonuclear cells.	Large mononuclear cells.	Small mononuclear cells.	Eosinophiles.
July 23, 1910 . . .	67.5	8.5	23.0	1.0
July 24, 1910 . . .	73.0	10.5	15.5	1.0
July 25, 1910 . . .	75.0	10.5	14.5	
August 22, 1910 . . .	81.5	5.5	12.5	0.5
August 23, 1910 . . .	65.5	13.5	20.0	1.0
August 24, 1910 . . .	75.0	11.0	13.0	1.0
Septembe: 10, 1910 . . .	81.5	10.5	8.0	
September 11, 1910 . . .	85.0	4.5	10.5	
September 12, 1910 . . .	89.0	4.5	6.5	

Patient died September 15, 1910

In the above case, while daily blood counts were taken, only the highest, the lowest and the average polymorphonuclear counts are tabulated, and again we see a progressively increasing percentage of polymorphonuclear cells with a decrease in mononuclear elements associated with a rapid increase in cancer growth.

In contradistinction to the above the following table is of interest:

TABLE III.—BLOOD CHANGES IN A PATIENT WITH RECURRENT CARCINOMA OF THE BREAST WITH POSSIBLE LUNG METASTASIS

Date.	Polymorphonuclear cells.	Large mononuclear cells.	Small mononuclear cells.	Mast.	Eosinophiles.	
January 20, 1911	65.5	7.5	26.0	0.0	1.0	Highest
January 30, 1911	46.0	12.0	40.0	0.0	2.0	Lowest
November 28, 1912	78.0	5.5	16.5	...	...	Highest
November 2, 1912	41.0	11.5	47.0	0.5	...	Lowest
	54.5	11.0	34.0	0.5	...	Average
March 26, 1913	65.5	6.0	28.5	...	...	Highest
September 19, 1913	42.0	13.5	41.0	2.0	1.5	Lowest
	55.5	10.0	33.5	1.0	...	Average
March 14, 1914	69.5	5.0	25.0	0.5	...	Highest
March 18, 1914	45.5	10.0	42.5	2.0	...	Lowest
	54.0	8.0	36.5	0.5	1.0	Average
April 28, 1915	67.0	10.0	23.0	0.5	0.5	Highest
April 30, 1915	37.0	11.5	50.5	0.0	1.0	Lowest
1920	51.5	8.5	39.0	0.5	0.5	Average

The above counts represent the highest, lowest and the average polymorphonuclear counts during a period of five years and one count at a ten-year period. At times long series of daily counts were made, and at no time during the first five years was there a greater lapse than a week between counts. The high polymorphonuclear counts observed were almost invariably associated with some intercurrent bacterial infection, such as a tonsillitis, etc., while the average was much below that observed in a normal individual.

Counts were stopped during the period of the war because of

the discontinuance of this work while one of the authors was in France. However, upon returning the patient was again seen and the work recommenced. During 1921 the blood picture changed, the total leukocytes increasing along with the percentage of polymorphonuclear cells and a corresponding decrease in the mononuclear percentage. Clinically, also, the disease showed progress and the patient was lost to further observation because of the desire to try radium treatments in another city. A few months later the patient died.

Thus the above table is illustrative of a case of advanced carcinoma which lived several years in fair comfort, during which time she was able to manufacture sufficient antibodies to cause the malignant process to be much retarded in its progress. At times it retrogressed, but for the most part remained about stationary. However, when this power was lost the disease advanced rapidly and death resulted quickly regardless of the treatment being used.

While we have records of many more cases, just one more will be cited to illustrate the points desired:

TABLE IV.—BLOOD CHANGES IN A PATIENT WITH ROUND-CELLED SARCOMA OF THE FEMUR

Date.	Polymorphonuclear cells.	Large mononuclear cells.	Small mononuclear cells.	Eosinophiles.	Mast cells.	
May 21, 1912	59.0	11.0	30.0	0.0	0.0	
May 23, 1913	54.0	14.0	31.5	0.0	0.5	
May 24, 1913	60.0	10.5	28.5	0.0	1.0	
November 11, 1913	46.0	12.5	41.5	0.0	0.0	Lowest poly.
February 27, 1914	67.0	9.5	22.5	0.0	1.0	Highest poly.
March 29, 1920	58.5	13.5	24.0	3.5	0.5	
1921	49.0	13.0	46.0	...	...	Average
1923	52.0	10.0	38.0	...	...	Average

In the above we see a constant good resistance in what is usually considered a very malignant type of tumor. During the past nine years no form of treatment whatsoever has been

given. There is no evidence of metastasis and the blood count always shows a good immune reaction.

It has been suggested that the blood changes following the parenteral introduction of cancer protein into a normal animal, such as was described at the start of this article, might be accounted for by the normal changes observed in digestion leukocytosis. While blood counts have been made coincidently upon normal animals which did not receive cancer protein and were kept under the same feeding conditions, and while these animals failed to show this marked change observed in animals which had received injections of cancer protein, yet it was thought possible that further proof that we were dealing with a specific reaction could be elicited. In order to accomplish this, cancer protein was implanted into the peritoneal cavity of guinea-pigs and blood counts made. At varying times the peritoneal cavities were opened and the tissue and whatever peritoneal exudate were present were removed. Figures 1 to 6 give a microscopical study of the findings and demonstrate the role of the large lymphocyte in forming substances antagonistic to cancer cells.

That a study of the leukocyte count can be of practical advantage to the general surgeon is illustrated by the following cases, in which the ability of the patients to form antibodies to carcinoma cells was estimated. This is done by preparing a cancer-cell emulsion or residue of from 0.5 to 1 per cent. The methods of preparation have been previously described. Suffice it to say that all such preparations must first be tested upon animals to see that they produce a satisfactory increase in large mononuclear lymphocytes.

Case 235.—Diagnosis: Carcinoma of the stomach. Blood examination showed 70 per cent of hemoglobin and the differential count gave polymorphonuclear cells, 75 per cent; large mononuclear cells, 6 per cent; small mononuclear cells, 18 per cent; mast cells, 1 per cent. One cc of cancer protein was injected intravenously and the twenty-four-hour count showed polymorphonuclear cells, 82 per cent; large mononuclear cells, 3

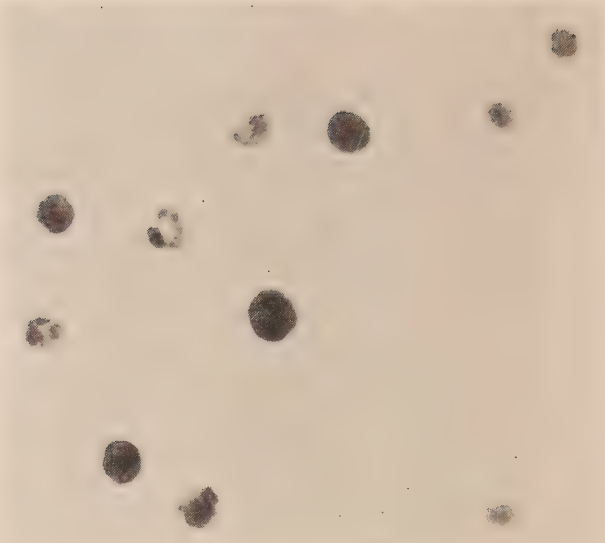

FIG. 1.—Shows the peritoneal exudate formed in a guinea-pig sixteen hours after the implantation of a small bit of fresh cancer tissue. It can be seen that the percentage of mononuclear cells is in excess of normal.

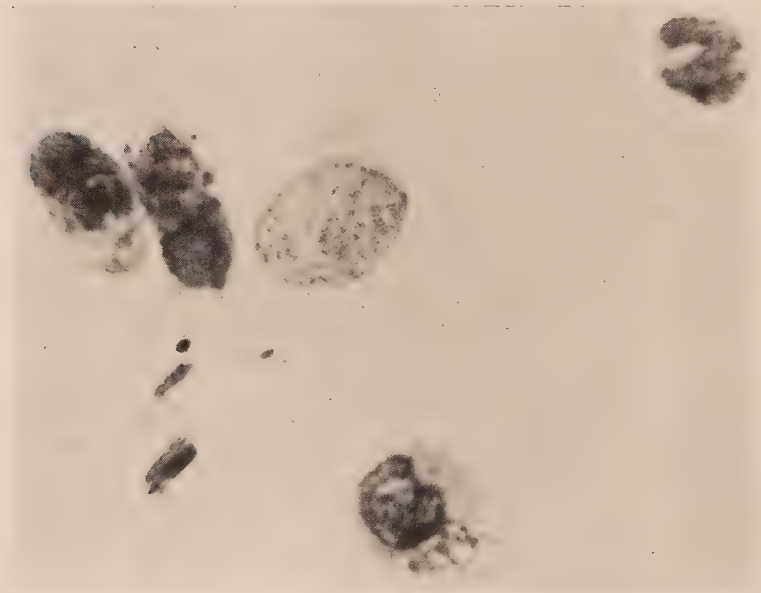

FIG. 2.—Illustrates the type of cells called into action, it being a higher magnification taken at twenty-four hours after implantation.

per cent; small mononuclear cells, 15 per cent. This finding demonstrated that the immune mechanism had been destroyed, in which case metastasis would be present, and that from a

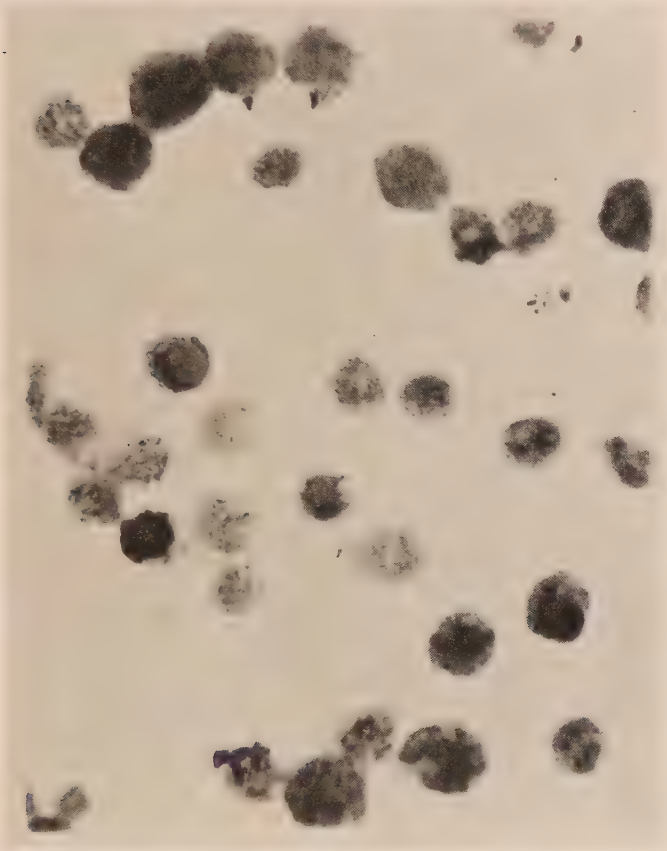

FIG. 3.—Illustrates the cells present at the end of thirty hours, together with some cancer cell débris.

surgical standpoint the case was inoperable. The *x*-ray findings also showed an extensive growth with almost complete obstruction. Operation was performed because of the obstructive lesion—at which time the liver showed metastatic nodules—

also the glands were involved and subsequent postmortem two months later revealed extensive retroperitoneal involvement with almost complete destruction of both suprarenals.

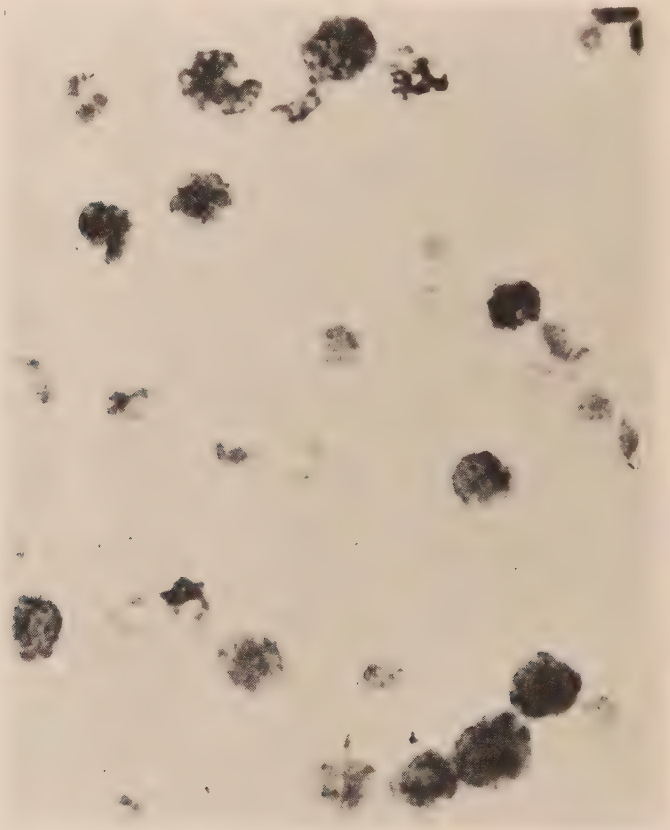

FIG. 4.—Shows the beginning of a slight increase of polymorphonuclear cells taken at forty-eight hours. It is extremely difficult to obtain fresh cancer tissue absolutely free from bacterial contamination, and, if bacteria be present they quickly call forth a polymorphonuclear increase.

In contradistinction to the above the following case is cited:

CASE 241.—Diagnosis: Carcinoma of stomach. Hemoglobin 40 per cent. Polymorphonuclear cells, 70 per cent; large mononuclear cells, 6 per cent; small mononuclear cells, 23 per cent;

eosinophiles, 1 per cent. A twenty-four-hour count after the injection for stimulation of the immune mechanism showed polymorphonuclear cells, 59 per cent; large mononuclear cells,

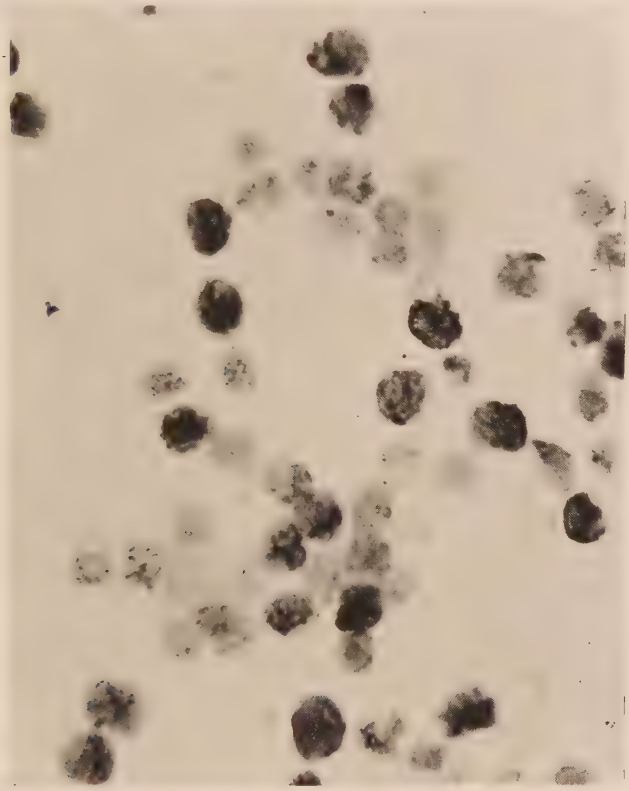

FIG. 5.—Illustrates this fact. Although the mononuclear cells are still in excess of normal, yet there is a large increase in the percentage of polymorphonuclear cells, many of which show eosinophile granules. This was removed at fifty hours after cancer-cell implantation in which cultures of the cancer material showed that bacterial infection was present.

15 per cent; small mononuclear cells, 25 per cent; mast cells, 1 per cent. While this case appeared clinically to be further advanced than the former, owing to the extremely low hemoglobin percentage, yet the test showed the immune mechanism

to be intact and that the low hemoglobin must be due to continued hemorrhage. Operation showed a small growth obstructing the pylorus. No metastasis was present, and it proved a suitable case for radical removal.

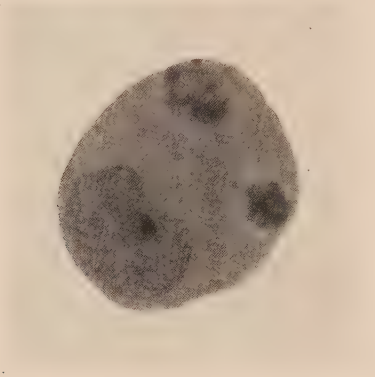

FIG. 6.—Shows a high magnification of a single large mononuclear cell found in the peritoneal exudate forty hours after implantation of sterile cancer tissue. The nucleus can be well seen, while contained within the other end of the cell are two pieces of nuclear débris of cancer cells. Such cells as this can always be found when the mononuclear leukocyte count is the highest, and it shows quite conclusively that this particular type of cell is the one which forms antibodies for the destruction of cancer cells.

Indeed, at the time when the mononuclear count is highest such cells containing the débris of cancer cells are not infrequently observed in smears made from the circulating blood, and it is quite possible that these are the bodies that formerly were thought to be an etiological factor in malignancy by former observers.

Thus it can be seen that in these 2 cases at least the question of removal of the malignant process previous to operation depended entirely upon the previous testing of the immune mechanism reaction. The same results have been obtained in cases in which the cancer was located in other organs.

CONCLUSIONS. Whether recurrence be rapid or slow after surgical removal of cancerous lesions, where all tumor tissue has not been removed, is dependent not upon the type of operation performed but upon the patient's own ability to form

antibodies antagonistic to the growth of cancer cells. This ability is evidenced by the percentage of mononuclear cells present in the circulating blood stream. When a high percentage of large mononuclear cells is noted for several days in succession the tumor retrogresses during that period. Conversely, when the count shows a high percentage of polymorphonuclear cells over a considerable number of days it signifies rapid tumor growth.

Metastasis usually does not occur until the immune mechanism has been destroyed and is no longer capable of being stimulated to renewed function. The injection of cancer protein or of a vaccine or residue prepared from any tissue that normally produces a decided increase in lymphocytes is a useful method of ascertaining the presence or absence of metastasis, since subsequent blood counts will demonstrate the ability of immune bodies to be formed. Occasionally, even with metastasis, the body will manufacture immune substances over a considerable period. It is such advanced cases that appear to cure themselves and in which the physician should be very guarded in making a prognosis as to the length of life. Such patients frequently live months after death has been predicted and furnish a fruitful field for the charlatan, since the temporary benefit observed from Nature's efforts is frequently credited to whatever medication is being used at the time.

In advanced malignancy with metastasis present there is usually a marked increase in the total number of leukocytes present in the blood stream. Associated with this is a high polymorphonuclear count, so that an afebrile blood count of 20,000 to 30,000 leukocytes with 80 per cent of polymorphonuclear leukocytes or above—such a count as one commonly sees in pneumonia—means almost invariably that malignancy with advanced metastasis is present.

DISCUSSION

Dr. J. L. Yates, Milwaukee:

Knowledge of cancer 1000 B.C. was in all essentials quite as accurate as that available up to the beginning of this century. During the past twenty years, because of experimental studies, more progress has been made than in the balance of medical history. The essential fact has been established. Cancer is not an entity but a disease, and like all diseases has an offense-defense complex.

There is a definite resistance against cancer which can be made to vary experimentally and clinically. Increasing and maintaining protection against the irritations that are the evils of cancer is the line treatment must take in the future.

Dr. Vaughan is to be commended and thanked for his invaluable additional evidence in favor of the existence of specific anticancer defense and the location of the same largely within the circulation.

ETHYLENE GAS ANESTHESIA

By ARTHUR DEAN BEVAN, M.D.
CHICAGO, ILL.

For many centuries surgeons sought for some means of relieving pain in surgical operations. The mandrake and the poppy, hyoscyamus and Indian hemp, and strong wines were used, and these agents must have been of considerable service, as we can realize from our present-day knowledge of the action of morphin and scopolamin; also morphin and whisky, which some of the early members of the American Surgical Association, like Senn, were fond of using in surgical operations about the mouth and jaws, combined with the intermittent use of ether, where they felt that semiconsciousness was safer than profound anesthesia.

Complete anesthesia in surgical operations was practically unknown until Morton's demonstration of ether in the Massachusetts General Hospital in 1846. It was then that Holmes coined the word descriptive of the new discovery. In 1844 Wells had used nitrous oxide in a few cases, but the importance of his discovery was not recognized, and it remained practically unknown until the introduction of ether startled the surgical world and made it keenly alive to the importance of anesthesia. In 1847 Simpson introduced the use of chloroform, which because of its ease of application and efficiency soon became the most generally employed anesthetic.

During the years that immediately followed the introduction of ether many other agents were experimented with. It was shown that anesthesia could be produced by the inhalation of nitrogen and ethylene and other gases.

In 1868 Edmund Andrews, of Chicago, first used the mixture of nitrous oxide and oxygen to produce prolonged anesthesia. Then came cocain in 1885 and the chapter of local anesthesia with this and other agents. In all of this development American surgery has played an important part.

During the last year some very interesting developments have been made in anesthesia. I refer first to the work of Luckhardt and his associates on ethylene and oxygen anesthesia and the work of Gauss and Wieland on anesthesia produced by acetylene gas and oxygen preceded by morphin and scopolamin. Luckhardt's work began in an interesting way: Some of the greenhouses which were growing carnations and shipping them into Chicago found that the flowers would go to sleep and that the buds failed to open, and they presented their problem to the botanical laboratory of the University of Chicago. Crocker and Knight, of that laboratory, undertook a study of the subject and found that illuminating gas was responsible for this effect on the carnations. On examination they found that ethylene, which forms 4 per cent of the gas, was the chief toxic constituent. They found that one part of ethylene in 2,000,000 parts of air caused the open flower to close and that one part in 1,000,000 prevented the opening of the buds. The toxic effect on flowering carnations suggested the possible toxicity of ethylene for animals and a series of experiments were undertaken by Luckhardt, who determined this fact. These experiments were carried on in the physiological laboratories of the University of Chicago by Dr. Luckhardt and his associates and assistant, Mr. Carter, at that time a student of medicine. Experiments were made on frogs, mice, rats, guinea-pigs, rabbits, kittens, dogs and finally man. It was soon demonstrated that complete anesthesia could be produced with from 80 to 90 per cent of ethylene with a corresponding 10 to 20 per cent of oxygen, and animals were repeatedly anesthetized. One dog was anesthetized about fifteen times in twenty-three days for forty-five minutes a day and then killed, and it was found that there had been no destructive effects on the organs or tissues of the animal. The experimenters then

began anesthetizing each other, and after they had demonstrated to their own satisfaction that complete anesthesia could be produced with a mixture of ethylene and oxygen, they made a demonstration to some of the members of the surgical department, including Dr. Dean Lewis, Dr. Dallas B. Phemister, Dr. Isabella Herb (the anesthetist at the Presbyterian Hospital) and myself. The members of the surgical department were so favorably impressed with the demonstration that I arranged to use it the following week on a series of surgical cases at the Presbyterian Hospital.

The first morning we used it upon 4 cases, as follows:

1. Some sebaceous tumors on the scalp. Here the anesthesia was very satisfactory. This minor operation was performed without any pain to the patient. Anesthesia was rapidly produced; the color of the patient was good, and the patient recovered within a few minutes from the anesthetic without any bad effects.

2. This was a case of fistula-in-ano, with some ulceration about the rectum, and was a severe test of the anesthetic, because it was the kind of a case which is very difficult to completely anesthetize with nitrous oxide and oxygen, and one in which we could seldom obtain complete relaxation from such a combination. In this case the relaxation was complete. The patient remained in the lithotomy position without rigidity of the lower extremities during the dilatation of the sphincter and during the dissecting out of the fistulous tract and the curetting of the ulcerated surface.

3. This was a case of inguinal hernia. The anesthesia was quite complete, sufficient to permit of the ordinary Bassini-Girard hernia operation, as well as though the patient had been under profound ether anesthesia.

4. A case of gall-bladder operation and the removal of a gall-bladder. In this case we used the sequence of ethylene gas and oxygen followed by drop ether. We did not attempt to do the operation under ethylene and oxygen alone, but in this case we used ethylene and oxygen simply as a preliminary to the drop ether, as we have done so frequently with nitrous oxide and oxygen. The transition from ethylene and oxygen to ether anes-

thesia was very satisfactory and was associated with no period of excitement.

Since that time the surgical staff of the Presbyterian Hospital have used ethylene and oxygen 239 times up to May 1 (up to October 1 in about 1000 cases). We have used the agent without giving any premedication, that is without giving morphin and scopolamin, so that narcosis was not influenced by any drug other than the anesthetic agent. In 199 of these administrations it was given alone. In 32 cases it was used as a preliminary to ether and it was combined with ether 8 times for short periods (four to fifteen minutes) during certain stages of the operation in order to secure better relaxation. In the early part of our work 2 patients (adult males) resisted narcosis, which was doubtless due to faulty technic, as later one of these was twice anesthetized without trouble. The occasion for the anesthetization of the second patient did not present itself, but we have no doubt that it could have been accomplished. Four patients who had had two or more operations and who could not be satisfactorily anesthetized with nitrous oxide—it being necessary to substitute ether—were given ethylene with marked success.

The youngest patient anesthetized was three years of age (congenital hip dislocation); the oldest was eighty-eight years (insertion of radium in the prostate). The shortest anesthesia was four minutes (carbuncle); the longest three hours and ten minutes (bone transplant). The latter patient was fully awake in five minutes and got off the cart into bed without assistance, although his leg was in a cast, and two hours after the operation he ate his supper. Good relaxation was obtained for a suprapubic prostatectomy in a man who weighed 258 pounds. In our series were patients suffering with myocarditis, acute and chronic bronchitis, emphysema, arteriosclerosis and diabetes. Two of the diabetics had two and three amputations for gangrene. None of these patients were unfavorably affected by the ethylene anesthesia. No change was observed in the urinary findings, blood chemistry or blood-pressure in the limited number of cases in which they were studied. It was noted that vomiting

(36 times) varied with different tanks. This was true both with fasting patients and those who had eaten their regular breakfast. The ethylene as it was delivered to us was supposed to be 99+ per cent pure, but as each tank had a different odor and vomiting occurred more frequently with some than with others, we concluded it was the impurities which caused the nausea. Fifty to 80 per cent oxygen was administered with the ethylene to a nine-year-old boy for a cystoscopic examination. Within the following two weeks the child was anesthetized twice, and each time the percentage of oxygen had to be decreased in order to secure quiet and relaxation.

While the number of operations performed under ethylene anesthesia is too small to make positive statements, certain deductions may be justifiable. It has been observed that the induction period is slightly longer than with N_2O, but analgesia lasts longer; furthermore, like ether, better relaxation is obtained if a few minutes are allowed after narcosis is developed before operation procedures are begun. It appears that patients pass more quietly to ether than when N_2O is given as a preliminary. Movements of the eyeball and the pupillary reactions parallel very closely those in nitrous-oxide anesthesia and are very valuable guides as to the degree of narcosis. When an insufficient amount of oxygen is given, jactitations occur just as in nitrous-oxide anesthesia. Repeated anesthesia require a longer period for induction and relaxation and a decrease in the percentage of oxygen.

I am personally very favorably impressed with the value of ethylene and oxygen anesthesia. I believe it is a much more efficient agent than nitrous oxide and oxygen. A brief, simple statement of its advantages is this: that we can secure and maintain complete anesthesia with 80 to 85 per cent of ethylene in combination with 15 to 20 per cent of oxygen. In other words the patient is receiving approximately the normal amount of oxygen that he obtains in breathing in ordinary air. That is the ordinary air contains about 20 per cent of oxygen and 80 per cent of nitrogen. This compares very favorably with nitrous-

oxide anesthesia which cannot be maintained deeply with much more than 7 or 8 per cent of oxygen and 92 or 93 per cent nitrous oxide. As a result the patient under the ethylene and oxygen mixture remains pink, of good color, where the patient under nitrous oxide and oxygen is frequently dusky, showing the lack of the normal amount of oxygen. In the second place the ethylene and oxygen anesthesia is much more profound and relaxation is much more complete. This is very well demonstrated by the fact that we can perform operations on the rectum, such as hemorrhoids, ulcer and fistula, and operations such as suprapubic prostatectomy, much more satisfactorily because we secure better relaxation under the ethylene and oxygen mixture than we can under nitrous oxide and oxygen. The result has been that we have been able to do a much larger percentage of our cases under the ethylene and oxygen mixture than we were ever able to do under the nitrous oxide and oxygen. My impression is that it requires a little longer time to produce anesthesia and that the patient requires a longer time to recover from the anesthesia under ethylene than under nitrous oxide. I find that this latter, however, is rather an advantage than an objection.

The other anesthetic agent which I desire to report briefly upon is the mixture of acetylene and oxygen. Gauss and Wieland make a report of 515 cases in which this mixture was employed in the gynecologic clinic of Gauss at Freiberg. Acetylene and oxygen are used just as ethylene and oxygen are employed, and in the same apparatus that is used for giving the mixture of nitrous oxide and oxygen. In all of these cases morphin and scopolamin were given before the anesthetic was administered. From their reports acetylene is a more powerful anesthetic than ethylene, and distinctly more powerful than nitrous oxide. It is, however, difficult to be sure of this fact because in their cases a preceding dose of morphin and scopolamin was given before the use of the acetylene, and in our cases we used no premedication of any kind. In the use of acetylene a lower percentage of acetylene is required, anesthesia being produced with from 60 per cent to 70 per cent of acetylene to 40 per cent and 30 per cent of

oxygen. The advantages claimed for acetylene are rapid induction, simplicity of administration, safety, absence of struggling and excitement and rapid recovery. The anesthetized patients appeared to be in natural sleep and without any change in color. Respiration was somewhat quicker than usual and the temperature fell about 1°. Relaxation was not as complete as with ether, although it was adequate for major operations. Gauss has used acetylene not only in surgical operations but also in confinement cases. He states that, like all general anesthetics, it diminishes uterine contractions.

One statement should be emphasized in regard to both acetylene and oxygen and ethylene and oxygen used as anesthetic agents. It is quite generally known that acetylene and oxygen when burned together produce enormous heat, sufficient to cut steel, and that in the proper mixture make an explosive of great power. The same is true of ethylene and oxygen. On that account the agent should not be used in the presence of a naked flame or in the presence of a cautery, and care should be taken to avoid the possibility of any accident.

Since reading this paper at the Rochester meeting of the American Surgical Association in May, 1923, we have used ethylene and oxygen in about 1000 cases at the Presbyterian Hospital. On the whole I think I can say that most of the surgical staff have been favorably impressed with the agent and feel that it is a more valuable agent than nitrous oxide, and are using it in an increasing percentage of the total number of our surgical operations. It has, however, definite limitations, and we have learned not to attempt to cover too large a field with this new agent. Where complete relaxation is needed in abdominal surgery, especially when the operation is in the upper abdomen, it is frequently impossible to obtain sufficient relaxation to complete the operation with ethylene, and it becomes necessary to add sufficient ether to produce relaxation. Then very often the anesthetist returns to the ethylene and oxygen mixture. It has been very satisfactory in almost all cases in surgery of the extremities, in hemorrhoids, operations on the

perineum, prostatectomy, hernia operations and in most cases of appendicitis but not all. In some cases of appendicitis it is necessary to add ether to obtain the desired relaxation. In stomach and gall-bladder work I prefer ether. We have used ethylene and oxygen very satisfactorily in doing radical amputations of the breast for carcinoma, and it has, like nitrous oxide, a particular field of usefulness in short operations, like opening abscesses and other infections, in reducing dislocations and fractures and in breaking up adhesions about the joints, operating on large carbuncles on the back of the neck, etc.

In our own work I should say that today we are doing about 30 per cent of our operations under local anesthesia and dividing the other 70 per cent about equally between ethylene and oxygen and ether. I hold no brief for ethylene as an anesthetic and I have no desire to present it in a partisan way or even in an enthusiastic way, but from our personal experience feel that the introduction of ethylene has given us a new anesthetic of definite value. It seems to be very safe and more efficient than nitrous oxide, but not as efficient as ether. I believe that it has a definite field of usefulness and should be employed by competent anesthetists in a large number of cases, so that we can definitely determine its field of usefulness and its limitations.

DISCUSSION

Dr. Dean Lewis, Chicago:

I have had the opportunity of observing the effects of ethylene in 76 cases. The patients become anesthetized rapidly, analgesia apparently preceding anesthesia in many cases. The most striking things are the natural color of the patient and the absence of sweating. Even after a prolonged anesthesia the skin is dry. There is no bronchial irritation and none of the patients have had a cough or any indication of any pulmonary complication. Hemorrhage is a little more marked than with other anesthesia, but this is readily controlled. The bright red appearance of the blood, due probably to the amount of oxygen that is administered, is striking. This may be noticed on sponges for some minutes.

I believe that the relaxation is better than that obtained by nitrous oxide. In operations upon the extremities, such as open operations for fractures and resections with bone transplantation, the relaxation has been perfect. In 1 case, an old Pott's fracture with dislocation backward of the foot, both the fibula and tibia had to be fractured and the astragalus reduced. The anesthesia in this case lasted fifty-five minutes and the relaxation was complete at all times.

In 3 cases ether has been substituted for ethylene. This was due mostly to timidity on my part, for I did not desire to take any risks. I believe that if we had persisted in these cases that the anesthetic would have been a success.

The margin of anesthesia is comparatively narrow, the patient passing from the anesthetic to the waking stage rapidly. Some experience will therefore be required to produce an even anesthesia. The patient may be rapidly rendered anesthetic if he comes out to some extent.

No marked vomiting has occurred. A number of patients have gulped up some mucous and bile on coming out. Many have been hungry and asked for food within two hours.

Ethylene seems to me to be a splendid anesthetic and to be deserving of much consideration and a thorough trial.

Dr. Kellogg Speed, Chicago:

I wish to confirm what has already been said. I have used this in 1 case of ununited fracture of the leg. The patient was under the anesthetic for three hours and fifteen minutes, due mostly to certain technical difficulties in the operation, but five minutes after the anesthetic was finished he was awake asking for food.

I agree entirely with what Dr. Lewis says about the margin of the anesthesia being very narrow.

X-RAY LESIONS AND THEIR SURGICAL TREATMENT

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(By Invitation.)

In 1909, in the *Boston Journal of Medical Research*, No. 3, vol. xxi, with Dr. S. B. Wolbach, I reported 47 cases of severe *x*-ray lesions, 6 of which were benign and 41 malignant; 14 were personal cases. At the time of this report 9 had already proved fatal. I have been unable to follow the foreign cases, but through the courtesy of my colleagues can give present results in almost all of the American cases, with a few autopsy reports. These cannot be called end-results, for lesions in some of them are still developing and further operations will have to be performed. Of this early series 8 more have died of recurrence and metastases. Those who are interested in following out the end-results of this first paper will find that we have placed after each name the number in the original report, with the date of death. Dr. Kassabian, Case No. IX, died in 1910; Dr. Early, Case No. XXIII, in 1912; Dr. Leonard, Case No. XIII, and Mr. Baker, Case No. VI, in 1913; Mr. Green, Case No. XVII, in 1914; Dr. Walter Dodd, Case No. XIX, in 1916; Dr. Glidden, Case No. XXI, in 1917, and Mr. Davis, Case No. XVI, in 1921. In addition, Dr. Caldwell, first operated upon by me in 1916, died in 1919.

In 1911, two years after my paper, Otto Heese, of Leipsic collected all of the then reported cases of *x*-ray carcinoma. There were 94, many of which followed the *x*-ray treatment of lupus.

Since then the bibliography has been extensive, and I have made no attempt to tabulate all cases, for the types continue to repeat themselves. In this paper I propose to analyze 107 cases, 44 of which are my own.

I have made five groups:

Group I. Lesions resulting from a single massive dose or a few exposures during a short period: (*a*) non-malignant; (*b*) malignant.

Group II. Cases with chronic disease like pulmonary tuberculosis; lupus, psoriasis; eczema, with many exposures over a long period: (*a*) non-malignant; (*b*) malignant.

Group III. Professional roentgenologists, many of them physicians who used the *x*-rays from the very beginning, before its dangers were known.

I find cancer rare in the first group, more common in the second group (the semiprofessional class) and most frequent in Group III, where in varying degree chronic *x*-ray dermatitis had been present for many years.

Group IV. Two cases of malignant disease, due chiefly, I believe, to radium, though there had been in addition a few *x*-ray exposures.

Group V. Four cases of sarcoma developing with or in chronic *x*-ray lesions.

In order that we may better understand the pathology of acute and chronic *x*-ray dermatitis, I shall submit an abstract by Prof. S. B. Wolbach:

A Summary of the Effects of Repeated *X*-ray Exposures upon the Human Skin Antecedent to the Formation of Carcinoma. This brief summary is based upon a review of the human material collected by Dr. Porter, which is included in his paper of 1909, and material from subsequent cases, to which I have added experimental tissues from guinea-pigs and rats. In the experimental exposure of animals to *x*-ray the earliest demonstrable histological change in the skin is a very striking swelling of the collagen of the corium and subcutaneous tissue: The bundles of collagen fibrils swell, the fibrils coalesce, producing

a compact, refractive greatly thickened corium. Coincident with this microscopic change there is a marked gross shrinkage of the skin, which can easily be observed if the area of exposure is outlined by means of a strong dyestuff. This effect on the collagen seems more or less specific and may be observed in the collagen in the walls of large bloodvessels and in the stroma of the appendages of the skin. Some of the connective-tissue cells are destroyed; many survive, as is evidenced by mitotic division a few days following exposure. Changes in the epidermis are to be observed on and after the fourth day and consist of swelling of the cells and mitotic division. These experimental tissues, furthermore, show that the maximum effect of the radiation is upon the superficial layers of the corium, because only in the superficial layers is there actual necrosis which calls forth a polymorphonuclear reaction. These minute necrotic gaps in experimental tissues may be seen to be filled with proliferated epidermis at the end of twelve days following a single exposure. A more or less permanent increase in thickness of the corium is brought about by the multiplication of fibroblasts and the formation of new collagen between the old collagen bundles. These observations in animals are comparable, as far as they go, with those observed in human skin. Just what the sequences in human skin are, following repeated exposures at varying intervals of time, must be left to speculation. It is safe to assume that a repetition of the effect described above occurs. There is no need to speculate, however, upon the objective findings in human skins that have reached the condition known as chronic *x*-ray dermatitis, and these changes may be summarized as follows:

1. Complete loss of the appendages of the epidermis.

2. Replacement of the normal collagen by a peculiarly dense, hyaline collagen, extraordinarily rich in elastic fibers and poor in cells.

3. Obliterative processes in bloodvessels of the corium and subcutaneous tissues.

4. Necroses of varying size in the corium immediately beneath the epidermis. In the earlier stages of chronic *x*-ray dermatitis

these necroses are usually in the neighborhood of thrombosed telangiectases. In the later stages of *x*-ray dermatitis the telangiectases may be nearly entirely absent.

5. In response to the necroses of the corium, reparative proliferation on the part of the epidermis. It is frequently possible to see regeneration of epidermis extending beneath thrombosed telangiectases and even small masses of necrotic corium. These small necrosis with the regenerative proliferation of the epithelium are responsible for some of the minute scales so characteristic of this condition. The significance of this lesion lies in the fact that it is invariably present in chronic *x*-ray dermatitis even after the lapse of many months or several years since the last exposure to radiation.

Detailed studies show that the immediate initial change occurring in these necroses is a focus of localized edema immediately beneath the epidermis, which in the 1909 article I referred to as areas of rarefication. The epidermis becomes separated from the viable corium by an edematous layer containing only necrotic cells and often infiltrated with fibrin. It has been impossible to demonstrate the actual vascular changes responsible for individual necroses, but the sequences suggest very strongly that the cause is a gradual obliteration of the capillary circulation brought about by shrinkage of the collagen. There is practically no attempt at repair of these minute subepithelial necroses owing to the pathological condition of the deeper lying connective tissues. The gap is speedily covered with epidermis, so that the effect of the occurrence of these necroses is to produce a downward migration of the epidermis, and the epidermis in these regions becomes altered probably because of the imperfect nutrition it receives from the peculiarly cicatrized corium. The effect upon the epidermis is evidenced by a thickening and imperfect differentiation into keratin, so that the superficial cells remain attached one to the other, resulting in thick accumulations of imperfectly keratinized fused epithelial cells. This I believe to be the origin of the keratoses so common in chronic *x*-ray dermatitis.

A factor which undoubtedly comes into action is the maintenance of the continuity of the epidermis over small areas by the proliferation of epithelial cells in the adjacent better nourished periphery, thus instituting a mechanism whereby constant epithelial proliferation is maintained.

In the consideration of the origin of epidermoid carcinoma in chronic *x*-ray dermatitis the outstanding fact of importance is that conditions are continually occurring which call forth proliferative activities on the part of the epidermis greatly in excess of the rate of normal proliferation or that which can be induced by conditions not involving the corium. We stress the observation that the acquisition of malignant properties is not a sudden one, that it is gradually acquired in the course of years. We believe that the epidermis is a transparent tissue and is not injured by the passage of the rays. Reactions of the epidermis we believe are secondary to lesions in its supporting tissue, the corium. For many years following injuries by the *x*-rays, the epidermis proliferates and behaves as it does in normal reparative processes. The acquisition of malignant properties comes as a result of sustained proliferative activities in contact with an abnormal supporting tissue.

In Group I the pathology is clear. After the first erythema and dermatitis there is usually an interval of weeks or months when a very painful slough of the skin occurs *en masse* or with ulcerations. In time much of the dead tissue comes away, leaving an ulcer covered by a characteristic adherent yellow fibrinous membrane exquisitely sensitive to touch. If the process has extended through the skin, white (or rather yellow) gangrene develops and a very tough area of tissue surrounded by partly obliterated vessels. No line of demarcation forms, as in ordinary anemic gangrene, but there seems to be sufficient vascularity to keep the part from dying outright, while there is inadequate reaction on the part of the surrounding tissue to cast off the slough. To the pain of a local neuritis, as the cicatricial tissue contracts, is added a definite compression of the nerves. Occasionally these cases heal spontaneously, often to break down

again, but most persist as chronic ulcerations covered by the peculiar yellow membrane. I am convinced that the best treatment for these acute or subacute lesions is early wide excision with skin-grafting or a plastic operation. If this is not feasible, owing to important structures deep in the wound, it must be left to granulate as best it will and operation delayed. Later, by skin-grafts, most defects can be repaired. It is very common to find the deep skin much thickened and requiring further excision before the wound finally heals. The immediate relief from pain which always follows adequate excision proves that the nerves within the diseased area are the cause of this pain. There were 17 cases in this group. Of these 8 were my own and all are well. There were 2 deaths: 1 from peritonitis after perforation into the general abdominal cavity from an extensive sloughing ulceration, the other a huge radium ulceration in the splenic region which demanded rib resection, etc., by Dr. Archibald. This patient died from secondary hemorrhage and pneumonia two days after a second operation. I have twice been compelled to excise part of both recti muscles and much of the lower abdominal wall. In 1 case a single massive treatment for keloid in an appendix scar had been given; the other case was exposed eight times on two successive days to determine the cause of a sciatica. In this last case three operations were done: The first was inadequate and showed characteristic necrosis of the deeper skin; a second operation with skin-grafting was apparently successful, but Dr. Wolbach reported that I had not yet reached normal tissue. He was right, for seven years afterward, in 1922, ulceration commenced again in the adjacent skin, which was further excised and the wound grafted this time with success. In 1898 Dr. McArthur, of Chicago, excised an area of gangrene 10 by 4 inches, which followed seven hours' exposure in three days. The excision included part of both recti muscles and the subcutaneous tissue over the sternum. The latter was covered with Thiersch grafts; the former was closed by a plastic operation on the abdominal wall. Ten years later a fall from a horse injured the scar and cancer developed. This was again

very radically operated upon by him, with removal of the mid-half of both recti and the underlying peritoneum with the round ligament. Tension sutures approximated the edges of this extensive wound. This patient lived until 1921 without recurrence and died of nephritis. If this late carcinoma developed as a result of the *x*-ray exposure, it shows that many years must elapse, even after radical excision, before the patient is free from the danger of malignancy. Cancer developed in 3 more of these cases—2 reported to me by Dr. Bevan and 1 by Dr. Ober, of Springfield, Mass.

Woman, aged fifty-three years. Five years ago had symptoms suggesting cancer of the stomach, confirmed by *x*-ray examination. Operated. Exploration was said to show an inoperable condition. Twelve *x*-ray treatments through the abdominal wall. One year afterward a chronic ulcer formed. Three years ago, in the right epigastrium, was an irregular indurated ulcer with a sloughing base surrounded by the usual chronic pigmented *x*-ray lesions. Specimens from the three excisions which shortly followed showed epidermoid cancer. The actual cautery was used. Radical operation seemed contraindicated by the extent and depth of the disease; there was no evidence of metastasis in the groin or axilla; chest *x*-rays were negative. At present there is a foul-smelling, cauliflower growth covering the whole of the upper abdomen; the patient continually requires morphia; there are no gastric symptoms whatever.

In Group II, subdivision *a*, there were 14 non-malignant cases treated for various lesions over long periods—10 personal and 4 others. There were no deaths; all are well and relieved of pain, but with some necessary disability. In some of these cases irritant ointments, arsenic, etc., were also used, particularly in psoriasis and eczema. In 2 syphilis may have played a role, and in several treatment with radium has complicated the picture. In 1 case the lesions were on the soles of the feet; in another on the back of the wrist, and in another on the palms of

both hands. Thorough excision and skin-grafting was the treatment employed, though amputation of a finger or toe was necessary in 2 cases. In subdivision *b* there are 11 cases of carcinoma, with 9 cures and 2 deaths. One case (Se.) was treated for eight years for ichthyosis of the palms; subacute dermatitis in 1913; an indurated ulcer formed on the left wrist treated with nitrate of silver and other caustics; grafting unsuccessful, then with radium and further grafting with the same bad results. My examination in 1916 showed extensive carcinoma of the whole front of wrist; amputation refused; thorough excision of ulceration reported as malignant and inadequately removed. In a few days a more thorough dissection was made, removing both arteries, the fascia over the nerves, superficial half of some tendons and intervening connective tissue; axillary glands removed and found to be non-malignant. Patient discharged at request and did not report again. Subsequently cancer recurred in the site of operation; amputation of the arm; death from internal metastases. A second fatal case was treated with *x*-ray for pruritus ani. After five years cancer of the skin over the sacrum developed; wide excision of skin, coccyx and sacrum with a plastic operation by S. J. Mixter. Recurrence at the end of a few months uninfluenced by radium treatment. Large cauliflower mass of cancer with internal metastasis and death.

Of the cured cases 2 are worthy of mention.

Mrs. H.; operated upon in 1902 by Dr. Maurice Richardson for fibrosarcoma of the abdominal wall. A recurrence took place, and, as the growth was considered inoperable by Dr. Coley, his serum was used, but without success. During the next two years 136 *x*-ray treatments were given by Dr. Skinner, of Hartford, with complete disappearance of the growth. The last treatment was given at the end of 1904. The patient was well for three years, when a huge ulceration of the lower abdominal wall occurred, which was exceedingly painful. There were several areas of carcinoma in the skin and excision included part

of both recti muscles. The ulcer refused to heal and was covered by the usual exudate. After a second wider and deeper operation with skin-grafting the wound finally healed after eleven months' treatment. This patient reported in my office two days ago. There are still characteristic *x*-ray lesions in the surrounding skin, but nothing of importance.

Another patient, Mrs. M., was treated six years for pulmonary tuberculosis. The right side of the neck, upper chest, front and back and breast were affected with all sorts of *x*-ray keratoses and ulcerations, some of which were malignant. Several radical operations were done, plastics and grafts. The patient was recently photographed and further operation done two months ago. She is now well.

In Group III, *a*, the non-malignant professional roentgenologists, there are 5 cases—4 personal and 1 other. All well after excision and skin-grafting, with amputation of a finger. In subdivision *b* carcinoma developed in 46 cases -15 personal and 31 others. There were 24 deaths and 20 remain well at the present time. Two were free from recurrence at the time of death: 1 of apoplexy and 1 of nephritis. Of the 24 deaths all died from extensive recurrence or internal metastasis. There were 10 shoulder-joint amputations: 1 interscapulothoracic amputation. While this appalling mortality of 52 per cent is undoubtedly too high, as many of the cases of cancer which have recovered have not been reported, it shows clearly the menace which threatens the older *x*-ray workers and the necessity for frequent observations to detect early malignant lesions, which have appeared as late as seventeen years after the last unprotected exposure.

Treatment. It is obvious that the indication for ideal treatment is the destruction of these lesions while in a benign or precancerous stage. While some of these professional lesions are found on the face, neck and chest, the great majority occur on the dorsal surface of the fingers and hands, almost never on the palmar surface or above the cuff-line. Telangiectases, keratoses,

painful cracks and fissures about the nails, with or without infection, epithelial thickenings and various degrees of ulcerations, intermittent or chronic, superficial or deep, we all know the picture, and the too common story of pumice-stone, salicylic acid, nitrate of silver, caustics and neglect. I wish to enter a protest against the use of all irritants in these cases. I am perfectly familiar with the good results sometimes obtained by carbon-dioxide snow, the various forms of electricity, sparking and coagulation, and particularly the proper use of radium, but my experience has shown many cases in which such treatment was persisted in too long with disastrous results.

Chronic Infections about the Nails. In almost all of these cases no method of treatment cures except avulsion of the nail and complete excision of the nail matrix at the base and also at the sides, a delicate and difficult operation, as proved so often by slight regrowth of some part of the nail.

Chronic Benign Keratoses, Superficial Plaques and Non-indurated Acute or Subacute Ulcerations. These may be treated by non-surgical methods if effective within a short time; but I believe that recurrent lesions, indurated or chronic and adherent ulcers, should always be excised and submitted to microscopic examination, without which it is often impossible to distinguish between a simple and malignant ulcer. If the lesion is not malignant, use skin-grafting by the technic to be described. If carcinoma is present and the margin is adequate—skin-grafting; if not adequate—wider excision or amputation. I have excised many superficial epitheliomata, particularly over the aponeurosis of the fingers or the tendons which have never recurred. No doubt radium might be equally effective, but I have never advised it in a case of proved cancer.

Technic of Skin-grafting. During my earlier work I used ether, or gas and ether, with a tourniquet applied to the finger or forearm in order that the delicate dissection could be carried out in a bloodless field. The bleeding was often excessive and prolonged, due either to the loss of vasomotor tone or to the tourniquet, and I have often waited an hour before I could apply the grafts.

When, as sometimes happened, a dozen or two grafts had to be fitted the operations become extremely tedious. I now operate in two stages under gas and oxygen. All lesions are excised and sterile, fine-meshed bandage cloth is placed flat upon the raw surfaces, with a splint, and firmly bandaged dressing before the tourniquet is removed. This two-stage operation has three advantages: (1) If tendons or aponeuroses are exposed at the first operation, at the end of four or five days they are covered with commencing granulations and a graft will grow. (2) The dressings are carefully removed under hot saline irrigation and the bleeding stops in a few minutes. (3) A chart of the lesions has been made and the pathological report of each is at hand. While waiting for the bleeding to stop the grafts are cut, usually from the arm of the affected side—not the leg, where the skin is too thick and coarse. Over an aponeurosis I use a thin graft, cut to fit the wound exactly without overlapping, and often suture it to the margin with very fine silk sutures, always passed from the graft to the skin. Thick Thiersch grafts are used from the thigh. All grafts are covered with perforated cellulose silk, cut in narrow or wide strips. The overlapping ends are moistened, with ether to fix them to the skin. Moist gauze, pressure and splint for one or two days, then exposure to the air under a cage. The serous oozing always present in these *x*-ray cases has seemed to me to contraindicate immediate exposure without pressure. As infection is usually present in some degree, particularly when a period of four or five days has intervened between the two operations, the grafts must be kept under observation so that blebs or pustules can be pricked lest the grafts become undermined. Alternate ointment and open-air treatment is often used in these cases. I have never seen keratoses recur in a graft unless the skin had been deeply shaved, not excised, though occasionally an ingrowth takes place from the surrounding skin. I have now over 100 grafts living on one patient's hands; some of the lesions were cancer, others would undoubtedly have become so. There has been no recurrence.

The proper treatment of enlarged epitrochlear or axillary

glands offers a peculiarly difficult problem –quite unlike that in cancer of the breast, for example, where the original source is removed and the more radical the glandular dissection the better. In most cases recurrent infections have already caused some chronic adenitis, and if a carcinomatous area has been excised from the hand there is a probability that other similar lesions may develop later. I believe that the removal of the guardian glands, if not malignant, is a misfortune, for the cells from a subsequent cancer may then pass directly into the general circulation. Whether a given enlarged gland or glands are inflammatory, malignant or both, is often a fine question of judgment. I recall one case in which I advised axillary dissection. The glands were tender and were thought by others to be inflammatory. Operation was delayed for months; the axillary glands were malignant; there was local recurrence and death. On the other hand, in a case of my own, previously mentioned, from which I removed non-malignant axillary glands and wrist amputation was refused, I made an error in judgment. Three cases bear witness that a thorough axillary dissection will cure: 1 is well eight years after operation; another eight and a half years after a most extensive involvement; the third, whose axilla I cleaned three years after amputation for cancer of a finger, was well for eleven years, when new disease developed on the back of the wrist—a late forearm amputation was performed, followed by rapid recurrence in the back and lungs. These cases show that when the glands have been removed any suspicious recurrent lesion demands immediate radical treatment.

Group V. I wish briefly to mention 4 cases of fibrosarcoma occurring with *x*-ray lesions: (1) a growth in the cheek, examined by Unna, of Vienna; (2) a case report sent to me by Dr. Follis, of Baltimore, of *x*-ray carcinoma, with also sarcoma of the finger, examined by Dr. Bloodgood, with axillary glands and fatal internal metastases; (3) one of my own with multiple carcinomata and sarcoma of the forehead, removed in 1909; no recurrence, but death from subsequent *x*-ray carcinomata with metastases in the liver in 1921; (4) a case with sarcoma and can-

cer of ring-finger; amputated in 1907; in 1910 sarcoma developed in the left tonsil, which was thoroughly removed by Dr. Crosby Greene without recurrence to date. These specimens have been recently studied by Profs. Wolbach and Wright, and the diagnosis is clear.

In Group IV there were 2 cases of cancer due, I believe, chiefly to recent radium exposures, and a third case in which it is difficult to say whether carcinoma which developed on the palmar side of the base of the little finger was caused by a long-lasting *x*-ray dermatitis or by subsequent exposure to radium. I fear that while the incidence of *x*-ray carcinoma is becoming less frequent, owing to well-understood precautions, that we may have an increase of radium cancers which will probably occur on the palmar surfaces of the thumb and forefinger of radiologists, not on the dorsum of the hand as in *x*-ray workers.

In conclusion I wish to speak of my friend, Dr. Walter Dodd, as an example of what some of the early roentgenologists have suffered. In 1898 I applied my first skin-grafts, which were successful. Benign lesions followed each other with numerous skin-grafts until 1902, when carcinoma first developed, followed by a finger amputation. By March, 1909, I had operated, under ether, 32 times, each operation from an hour and a half to three hours in length. Amputation at the wrists was considered, but refused by the patient. As there were no lesions on the forearms such an operation performed at this time might have resulted in a cure. Other operations followed, until in 1915 a carcinoma developed on the outer side of the back of the left hand, which led to a definite increase of already enlarged glands in the axilla. Partial amputation of the hand was followed by removal of a carcinomatous epitrochlear gland and a most thorough dissection of the axilla. Numerous skin-grafts were applied to the back of the hand. The patient was brought to the train in an ambulance to serve as a roentgenologist with the first Harvard unit in France. During the summer of 1915, in spite of a somewhat crippled condition, he did splendid work in France, and was in better general condition than he had been for years.

Early in 1916 partial amputation of the right hand became necessary and the right epitrochlear with the axillary glands were removed. Soon an unproductive cough developed; he lost weight; refused *x*-ray treatment of his chest; and died on December 17, 1916. Postmortem examination showed no superficial malignant disease whatever, but both lungs were filled with softened nodules of epithelial cancer. From 1902 to 1916 more than 30 different carcinomata had developed, and in all 57 operations had been performed.

DISCUSSION

Dr. Lewis L. McArthur, Chicago:

As you will recall, the *x*-ray was first introduced in October, 1897. The following year, 1898, we got a machine in Chicago. In 1899 an army officer who had received a bullet wound over the sacrum came to me for an operation in order to avoid retirement from service because he was lame in the right thigh. Dr. Schmidt saw him with me and we decided that the wasting lesion was due to injury of the anterior crural nerve. It seemed feasible that if suture of the nerve could be made he would not be retired. Efforts were made to find the bullet. He had several exposures, first of one minute and again of five minutes, and it did not show. As a result of this exposure he was burned from the pubis to the xiphoid. After three months the wound was a 10-inch by 4-inch ulcer. This was excised. The skin was undermined on each side and a "major" was converted into a "second lieutenant" by pulling the edges together. He then developed carcinoma of the cicatrices. No metastasis was found internally.

One more word: The very remarkable *a priori* reasoning which was made by Dr. William A. Pusey, of Chicago, at the New York Dermatological Society meeting in 1901, when he said that "the first effect of these *x*-ray burns is that of producing a final keratosis, in which the examination microscopically cannot be differentiated: Therefore, I predict that within a few years you will be having epithelioma coming to you due to *x*-ray burns," and within two years that occurred, and the prediction has proved to be correct.

Three weeks ago I reported before the Chicago Surgical Society and showed a patient (a man) in whom a dentist in doing some dental work broke off a drill, the point of which remained in his jaw. He consulted a surgeon who tried to remove it before the fluoroscope and spent twenty-five minutes in trying to get it. He did not succeed, but did succeed in burning his own hands and also the patient's. The patient developed an eczematous dermatitis of the entire dorsum that took three months to heal to the size of a cent, which left a dull-gray ulcer on the back of his hand for six months. In May of the following year he went to a dermatologist who thought he could cure him with the ultraviolet rays. This small ulcer on the hand was treated on May 27 and again on June 2. After that the whole dorsum of the hand sloughed—he lost his fingers and tendons and came back to me with an absolutely useless hand, except

for the index finger and thumb, which I preserved for him by making a sliding graft and putting it under a flap of skin.

I think very decidedly that the use of the ultraviolet rays upon *x*-ray burns should be avoided.

DR. BURTON J. LEE, New York:

This contribution of Dr. Porter's is a very timely one. I want to emphasize two or three points.

Concerning the use of the *x*-rays as a therapeutic agent: Most of the cases of epithelioma which one encounters from the use of the *x*-rays are those in which the old type of therapy was given. We have a number of cases of this type which have come to the Memorial Hospital. I think Dr. Porter's treatment of wide surgical excision is the correct one.

Dr. Porter brought up the question of the use of radium: I think I would never use radium in any form of an *x*-ray burn.

This subject is very important because at present throughout this country we hear a great deal about so-called *x*-ray therapy, and I feel that as surgeons we owe an obligation to our patients as well as to others to inform ourselves more thoroughly about the subject of radiation—what it really means and what it really does. The study of these *x*-ray burns with ultimate development of epithelioma emphasizes what is so well known, that the changes which take place from radiation are not only skin changes, but deeper ones in the subcutaneous tissues, interfering with the blood supply and sometimes resulting in serious damage to all tissues.

On the other hand, I do feel that when radiation is well planned and carefully employed that no such serious consequences as Dr. Porter's cases illustrate need be feared.

One word of caution about deep *x*-ray therapeutic machines: We have such a machine at the Memorial Hospital, built upon specifications by Prof. Shearer, of Cornell. When the machine was placed in position no patient was treated for three months and there were numerous conferences by the various members of the staff as to the proper use of this machine. We did experimental work with it and no case has been subjected to the so-called deep therapy at Memorial Hospital without a proper consideration of all factors and feeling perfectly sure of our ground that the case really needed deep therapy.

Recently, seeing a series of breast cases in another city, I found than an *x*-ray man had recently put in a large deep therapy machine and was treating all cases with so-called deep therapy. That, of course, is illogical. I must confess that in this instance I felt that

the man had an expensive machine and wanted as many cases as possible treated by it to cover his initial outlay.

At the present time, at Memorial Hospital, almost invariably our treatment is by the old type machine. One cycle of *x*-ray treatment is given and we stop there. A patient is followed month by month but no further radiation is given, and subsequent treatment is determined by the development of the case.

Finally, an obligation rests upon us as surgeons to properly inform ourselves about the science of radiotherapy.

Dr. John H. Gibbon, Philadelphia:

I wish to emphasize one point which Dr. Porter made and which I think we are all agreed upon, namely, there is no treatment for an *x*-ray ulcer except excision.

There is a widespread habit of treating the irritation and pain in the early stages with various chemical solutions and of treating the ulcer later with antiseptic solutions. Both are bad: The first tends to produce ulceration and the second only aggravates it. Protection with "ambrine," or some similar preparation of paraffin, is most useful before and after ulceration. If healing does not occur under this treatment excision should be done. Any other form of treatment is dangerous.

Dr. Leonard Freeman, Denver:

My experience with this work has not been as large as Dr. Porter's, who is the acknowledged authority on this subject. It has been great enough, however, to convince me of two things:

1. When a portion of skin is at all seriously injured it is necessary to cut that skin out in its entirety, and the sooner the better—not only because it will not heal, but also because of the danger of malignancy.

2. That Thiersch-grafts, when grafting is necessary, are not as reliable as whole-thickness grafts, and should not be used where it is possible to use the full thickness of the skin. Thiersch-grafts are not resisting enough and tend to become reinvolved from the edges and even from beneath.

I recall the instance of a doctor who belongs in Dr. Porter's third class, who used the *x*-rays when they were first introduced. He was badly burned about the hands. He went to Dr. Porter, of Boston, who very skilfully and properly placed Thiersch-grafts upon the backs of his hands. These did well at first, but after he returned to Denver it became necessary for me to replace all these Thiersch-

grafts with full-thickness grafts, which answered very satisfactorily, even over the knuckles.

I do not see any reason for any particular method of skin-grafting in *x*-ray burns. The ordinary methods have served me perfectly well.

Regarding the use of radium, I know of one instance in which an *x*-ray burn on the back of the hand was so treated, and it was made worse.

Dr. Willy Meyer, New York:

I would like to mention an observation recently made in a case of chronic eczema. A colleague had advised radium. The patient was given one exposure for half an hour posterior to the inner malleolus. This resulted in the formation of an ulcer after two weeks. When I saw him several weeks later he had a deep ulceration with thickened borders. I tried everything I could think of for use in such cases, but there was no change and little hope of improvement without excision and grafting, which was proposed. He was a very busy man and did not have the time to go to a hospital. He therefore asked that something else be tried. I said that I could only think of an attempt with hyperemic treatment. This was done and continued for more than three months, suction being used every other day at the office and the elastic bandage applied around the thigh at home overnight. The ulcer healed completely in the early part of this year and the infiltrated border became perfectly smooth. There was no recurrence.

The case proves clinically that the sclerosis of the bloodvessels resulting from the ray overdose can yield to artificial hyperemia and that not every case of this kind must necessarily be subjected to operation.

Dr. Vilray P. Blair, St. Louis:

I wish to mention a case of heat burn which seems to resemble that to which Dr. Porter referred.

A woman, seven years ago, was burned with a hot-water bottle, which resulted in an ulcer. It was painful all the time. Four years later she had ultraviolet-ray treatment, but this did not appear to influence it. When she consulted me she had an ulcer 2 cm. deep and over 5 cm. in diameter over the lumbar spine, situated in an area of telangiectatic skin which in area and shape corresponded to the surface of a hot-water bottle. This patient's pain was entirely relieved by the excision of the whole of the scarred area, including

the base of the ulcer. The area was closed by switching large flaps. There was no history in this case of ever having been exposed to *x*-ray, and yet its behavior and appearance was typical of an *x*-ray burn.

Dr. Rudolph Matas, New Orleans:

I cannot allow this opportunity to pass without a word of appreciation for the admirable work that Dr. Porter has done and is doing for the profession in his continued studies on *x*-ray burns and in the treatment of this unfortunate class of patients. His contributions to the subject have been of great interest to me, and I cannot thank him sufficiently for the benefit that I have derived from them.

There is one phase of the discussion that I would like to touch upon. This refers to *the delayed or remote appearance of x-ray burns after long periods of latency*. We are all familiar with the classical degenerating and destructive effects of *x*-ray or radium radiations which we designate in general terms as *x*-ray burns or radiodermatitis, but the appearance of these effects after lengthy periods—two, three or four years—have elapsed, and the patients have recovered from the immediate effects of these radiations, are not so familiar or easily explained.

I had the misfortune of making my first acquaintance with *x*-ray burns many years ago, in the early nineties, when radiotherapy was still in its infancy and when this mode of treatment was practised largely in an empirical fashion with no precise scientific data in regard to screening or dosage to guide us. I have two patients in mind who came under my observation at that early period whose experience illustrates most strikingly the *latent* or long-delayed effect of radiotherapy. In these, the injurious and destructive lesions caused by the rays on the skin and subdermal tissues did not appear until three or four years, respectively, *after* the roentgenotherapy had been discontinued and the patients had recovered from its immediate effect. In view of the extraordinary length of the period of latency, the comparative rarity of such cases and the unsuspected dangers that they reveal, they are worthy, I believe, of special mention on this occasion. One of these two experiences goes back to 1901.

A young woman, Miss A. P., aged twenty-five years, of a very fair, blonde type, came for the treatment of a typical advanced exophthalmic goiter, with all the characteristic neck, eye, cardiovascular and neuropathic manifestation. She was subjected to a systematic course of *x*-ray radiations, generated by an old-fashioned

static machine and delivered by a hard tube without screening. Unfortunately the precise focal distance, duration and other technical details have not been recorded. Suffice it to say that the patient was treated serially, at intervals of months between the exposures, for three years. The treatments were always stopped when the characteristic erythema appeared.

At the end of the third year the thyrotoxic symptoms had ceased, the exophthalmos and ocular signs had subsided, the goiter had been reduced to normal and the cardiovascular symptoms had completely abated. A cure, seemingly, had been effected. The skin of the neck, chest and breasts, as far as the nipples, had undergone some atrophic changes and characteristic telangiectatic streaks crossed the field of radiation at various places.

Apart from these relics of her treatment the patient remained well for nearly *four* years (October, 1907), when the skin of the neck became thickened, infiltrated and patches of gangrenous dermatitis appeared. These patches coalesced and spread over the whole area of radiation, from the chin to the midsternum and the upper surface of the mammæ to the nipple-line and laterally to the clavicles and costal cartilages. By January 16, 1908, she began to display toxic (septic) symptoms—delirium, stupor, fever, albuminuria with involuntary micturition and defecation—with correspondingly weak and rapid pulse. The general aspect of the patient suggested an atypical form of meningitis. There were no exophthalmic signs, no enlargement of the thyroid suggestive of a relapsing thyrotoxism—at least of a Basedow type. The patient remained in an uncertain condition for six weeks, when she gradually regained consciousness and strength and was finally transferred from the hospital to her home, by the end of the ninth week. In the meantime the ulceration in the neck and chest had come to a standstill; the sloughs had been cleared away and the foul, ichorous secretion had greatly diminished, but there was no attempt at healing. An attempt to promote healing by implanting a number of pin-grafts was made five months after the patient's return home, but this failed and the ulceration continued intractable, though much better defined and circumscribed. It was not until July, 1910, two years after the first attempt, that Dr. Smyth, her attending physician, succeeded in healing the whole ulcerated area by excising the entire area of damaged skin and covering the raw surface with sliding flaps and Thiersch-grafts. From this on the patient made an uninterrupted recovery, and, with the exception of an intercurrent attack of appendicitis, remained well and completely free from thyrotoxic symptoms or from recurrence of the ulceration.

Seven years after her recovery from the *x*-ray burn the patient married and has remained well.

In this way the profound toxemia which coincided with the appearance of the ulcerative radiodermatitis, and which threatened the patient's life for nearly six weeks, is a notable and singular feature with no parallel experience that I can find in my search through the literature.

The second case exhibited a similar period of latency, but was not so fortunate in its termination:

The patient, Mrs. S. R. P., a widow, aged fifty-eight years, of a dark brunette type, was operated for an advanced carcinoma of the left breast, with axillary metastases, in 1903. A radical axillo-mammectomy on Halsted lines was performed, the pectorals were removed with the breast and the denuded chest was covered with sliding flaps. She recovered uneventfully from the operation, leaving, however, a long scar area with a thin covering of skin adherent to the ribs. Prophylactic roentgenotherapy (unscreened) of the whole field of the operation was instituted in series, which continued at intervals for three years (1903–1906). The radiations were discontinued whenever a distinct erythema appeared. The patient remained well for *three* years after the last radiation, when suddenly, in 1907, a gangrenous dermatitis appeared in patches over the radiated areas. These patches coalesced and left a large ulcerated area, which broke down the whole line of the scar. Intense burning pains began with the appearance of the dermatitis, which continued with remissions and exacerbations until her death, which occurred in the present year (1923).

The ulcerated areas were rebellious to all treatment and the pain and intense itching were so severe that codein and then morphia had to be given freely to relieve her. It was impossible to excise the ulcer and diseased area, as this would have necessitated a resection of the chest wall and there was no available sound skin anywhere in the vicinity to permit a closure with flaps. As the ulcer contracted its edges became callous, horny in places and under these horny concretions an epidermoid carcinoma developed which was indolent and was only partially relieved by radium. However, the patient gradually grew weaker from malnutrition, marasmus and exhaustion and died.

The original cancer of the breast (an adenocarcinoma) did not recur. The small epidermoid carcinoma which appeared in the scar

eighteen years after the amputation of the breast only contributed in a small way to her death. The real cause of death was the protracted septic suppuration, ulceration, pain and malnutrition complicated by chronic malarial toxemia, all combining to undermine the resistance of the patient, who had now reached the age of seventy-eight years.

The recent roentgenological literature records a considerable number of interesting illustrations of delayed *x*-ray burns, but very few in which the period of latency has exceeded more than a few months. In fact, until quite recently, I thought that the two cases just reported have surpassed all others in the great length of the period of latency. However, I have since found a parallel case in which the appearance of the dermal lesions (radiodermatitis followed by intractable ulceration with all the characteristic signs) was delayed fully four years after the patient had recovered completely from a bleeding uterine fibromyoma which had been successfully treated by radiation. The case is reported by Dr. Karl Grasmann, of Munich, in the *Deutsche Zeitschrift für Chirurgie*, 1923, No. 1-2, clxxix, 115–129, and is utilized by the author as a text for a most thorough and excellent contribution to the subject of delayed *x*-ray burns. The history of this patient is described with the most precise technical details which clearly show that *x*-ray burns may make their appearance in the field of radiation after extraordinarily long periods of latency; furthermore, that these remote destructive lesions may occur in spite of the most carefully screened and dosed exposures administered by expert radiologists. In the case related by Grasmann the technic adopted was seemingly irreproachable, as shown by the detailed radiological protocols which were kept on file at the Roentgenological Institute of Munich. The treatment was begun in May, 1916, and the patient was discharged apparently well in July, 1916, after undergoing a series of four intermittent radiotherapic sittings applied by cross-firing over the abdominal wall and back and over well-plotted fields. When the patient was discharged she showed no dermal lesions or signs of any injurious radiodermal reactions. Nevertheless, the patient returned in April, 1920, four years after her discharge, with a typical burning dermatitis in the buttocks and lumbar region, which was followed by ulceration in the right buttock below the level of the sacroiliac synchondrosis. At first the appearance of these ulcerative patches led to many conjectures as to their cause, but the appearance of the typical ulcer and the associate lesions revealed its true character. The ulcer resisted all forms of topical

medication until it was finally excised in June, 1920, when the patient was cured. Complete recovery was confirmed two years after the operation in the summer of 1922.

Grasmann's report of this case is made especially valuable by a very thorough histologic study of the excised tissues by Prof. Duerck, which shows conclusively that the underlying pathology of these long-delayed and necrogenic *x*-ray burns is a progressive proliferative endarteritis which obliterates the arterioles of the derm and subdermal connective tissue, leading to a gradual but fatal ischemia and nutritional disturbances in the radiated field. Whether this endarterial obliteration is initiated primarily in the endothelium of the arterioles and capillaries or is secondary to correlated changes in the perivascular connective tissue is not fully determined, but the fact remains that the mystery of this long period of latency is explained by the slow but progressive obliteration of the vessels which continues indefinitely once the endothelial proliferation has been started by the penetration of the rays.

Now as regards the treatment of these notoriously rebellious radiodermal lesions, my experience fully confirms the general observation that once an *x*-ray burn has advanced to ulceration, practically nothing will accomplish its cure but a total excision of the entire diseased area, provided this can be covered by healthy well-nourished flaps or by grafts applied to a perfectly healthy base. However, much can be accomplished for the relief of the intolerable pain that is peculiar to these burns, and even the healing may be promoted and obtained in the more superficial ulcerations by suitable topical applications. Of these I may state that, in a recent experience with several cases of radiodermatitis caused by *x*-rays and by radium with superficial necrotic ulceration, I have obtained the most satisfactory results by the use of Fischer's fluid, now known by the trade name of "incitamin." This fluid has given almost immediate relief to the pain and has also cleared the ulcers of sloughs and promoted healing in a way that is far superior to the many local applications which have been hitherto recommended. I first became acquainted with this remedy through an article published in the *London Lancet* (October 29, 1921) by Dr. J. L. Fischer, Director-General of the Municipal Roentgen Clinics of Copenhagen, Denmark. It purports to be a compound of horse serum, treated with trypsin, freed from coagulable substances, horse saliva and carbolic acid (0.5 of 1 per cent) as a preservative. The exact mode of manufacture is not given, and in this sense it is a proprietary article. It is applied directly to the

diseased surfaces as a gauze compress soaked in the fluid and kept continuously moist by covering with fine rubber or oil-silk tissue kept in place by a retentive dressing. The dressings are renewed morning and evening or as often as may be required to prevent the accumulation of secretions and to relieve pain. It is non-toxic and non-irritating to the skin, and the patients for whom I have prescribed it have all expressed great relief from its immediate soothing effect. It clears these usually foul ulcers from sloughs and keeps them clean and in better condition to heal. It is applicable to all chronic indolent, intractable ulcers, including chronic painful varicose ulcers and malignant cancerous sores. It is especially valuable in *x*-ray and radium burns for which it was originally devised. While it is not claimed to be a panacea for all chronic ulcers and has no specific virtue, it is a palliative analgesic and antiseptic agent of undoubted value as an adjunct to other surgical and more radical methods of treatment that may be indicated. In the superficial radiodermal lesions it promotes healing far more effectively and pleasantly than any other application we have tried thus far. A central agency has been established for the sale of this article in Chicago, and it can now be obtained from the leading druggists.

Dr. Porter (in closing):

I often cut a very thick Thiersch-graft, which is almost equivalent to a Wolff graft. It has been my experience that thin grafts are more apt to grow on granulating wounds or tissues with relatively poor blood supply, but the ultimate result is less good than thicker grafts, if they are successful. In deciding upon thick or thin grafts, one should be influenced by the surface of the wound. In recent years I have sutured the grafts to the edges of the wound, particularly on the hand, where small grafts often tend to creep under the dressing.

Cutting large grafts with a knife is an art as definite as playing the violin, in which the younger surgeons, who have been brought up on a safety razor, are handicapped, until someone invents a graft-cutter, which will work automatically to the thousandth of an inch.

I think Dr. Freeman is to be congratulated on his results.

ON THE CONTINUED INTRAVENOUS "DRIP"

WITH REMARKS ON THE VALUE OF CONTINUED GASTRIC DRAINAGE AND IRRIGATION BY NASAL INTUBATION WITH A GASTRODUODENAL TUBE (JUTTE) IN SURGICAL PRACTICE

By RUDOLPH MATAS, M.D.
NEW ORLEANS, LA.

1. The purpose and gist of this communication is to direct attention to the value and advantages of the intravenous route for the direct and *continuous instillation* of fluids intended to replace the volume of lost blood and for infusing stimulating, nutrient and medicated solutions in shocked, toxic, exhausted and dehydrated surgical subjects in whom the usual indirect avenues of the circulation and the tissues are either unavailable, insufficient or inefficient when there is urgent need of a *prolonged prop* to the circulation in the great emergencies or crises of surgical practice.

2. By the intravenous "drip" is meant the direct administration of artificial sera (replacing, nutrient and medicated), *drop by drop*, into a selected vein for such variable periods of time (usually from one to six days and over) as may be required to restore the vascular equilibrium and rally the patient until the defensive cardiovascular mechanism has had time to assert itself or it is evident that it has failed to respond to artificial aids.

3. The intravenous drip is not intended as a routine substitute for, but as a secondary measure to follow, the primary massive intravenous infusion of sera (saline or glucose solution) which,

in profoundly shocked, exhausted and starved surgical patients, are more often temporary or ephemeral in their effects.

In many shocked patients, as we all know, the immediate restorative effect of a hot intravenous salt or glucose infusion is; for the time being, brilliant; but this effect is more often transitory, so much so that it suggests that the fluid injected has simply run out of the vessels into the tissues, just as if that much water had been poured into a sieve. Hence the efforts that have been made to hold the infused fluids in the circulation which we recognize in the introduction of the gum-salt solution of Bayliss, the gelatin of Hagens, etc., which tend to imitate plasma, rather than the serum of the blood, by increasing the viscosity of the injected fluid.

But even then dilution soon follows, and these solutions, which cannot be injected indefinitely, soon seep out of the vessels or accumulate in the reservoirs of the great splanchnic veins, leaving the arterial system empty, the peripheral capillary circuit stagnant and the patient as collapsed as before the infusion. The advantage of the *constant* drip lies in the steady stimulation with an isotonic oxygen and pabulum-carrying fluid which not only replaces the lost fluid for an indefinite time but stimulates and nourishes the heart muscles and brain centers continuously without overcrowding the heart. Thus the storing of energy in the cellular batteries is kept up and the metabolic processes continued, provided no permanent degenerating or necrogenic cellular changes in the vital territories of the master organs have already occurred, which would make them incapable of responding to any form of stimulation.

4. The value of the continuous intravenous drip is especially apparent in the postoperative treatment of septic abdominal cases in which dehydration and exhaustion, caused by prolonged vomiting and fasting from mechanical obstruction or toxemia, have preceded the operative act, and when the absorbent and eliminating functions, as well as the mobility of the gastro-intestinal tract, have been so paralyzed and inhibited that the usual avenues of supply by the oral, rectal, hypodermal or

gastroduodenal route *via* the duodenal tube (Jutte, Rehfuss, Einhorn) or even the cholecyst-duodenal drip (McArthur, Matas) are blocked or unavailable.

5. Notable examples are: Intestinal obstruction and septic peritonitis from multiple perforating gunshot wounds of the abdomen, ruptured appendix, perforating gastric and duodenal ulcers, obstructed common duct with hepatic insufficiency, gangrenous gall-bladder, advanced pyloric obstruction from carcinoma or benign stricture, with marasmus from prolonged starvation, or after nephrectomy for pyonephrosis with threatened anuria. In many of these, and especially the delayed cases, operations have to be performed in which the primary focus of infection or an obstructive lesion is removed; but the patient is left profoundly shocked, toxic and exhausted, with empty arteries, a stagnant capillary and venous circulation, and with dry, dehydrated tissues dying of thirst and starvation.

6. Every surgeon of experience knows that in the particularly grave cases that we have in mind the *rectal* drip (proctoclysis), even when retained, is of little or no service; it is frequently not absorbed, especially when the portal circulation is stagnant, as in advanced peritonitis with marked tympanites, and it is frequently not retained or even tolerated, and therefore fails when it is most needed. *Hypodermoclysis*, which is most useful as a preliminary measure or during the operation, also fails when the capillary circulation is at a standstill or failing from shock after the operation. Subcutaneous absorption is then either so long delayed or suspended from capillary stasis that very little of the fluid is absorbed and remains in great edematous collections under the skin. The same may be said of the *gastric or duodenal drip* administered through a small duodenal tube (Jutte) introduced through the nose into the stomach and allowed to remain *in situ*. When the intestinal tract is paralyzed and peristalsis is arrested or reversed (regurgitation of intestinal contents) the fluids introduced through the tube accumulate in the stomach and are not absorbed. When septic peritonitis, acute gastric dilatation or adynamic intestinal

paralysis complicate an operation for chronic obstructive jaundice or from other causes, the fluids introduced into the duodenum *via* the gall-bladder ("McArthur drip") or through a catheter introduced into the common duct ("Matas drip") are regurgitated into the stomach and not absorbed even after all obstructions to the common duct have been removed.

7. In the presence of a collapsed, practically pulseless patient, when it is evident that none of the above-mentioned indirect methods of restoration is efficient or available, the first and prime indication is met by the prompt *intravenous infusion* of a stimulating isotonic fluid capable of replacing the lost or displaced blood.

8. The transfusion of citrated or, preferably, whole blood is undoubtedly the most efficient restorative, but this is not always available in emergencies; nor is its immediate beneficial effects always sustained, nor can it be applied continuously for an indefinite time when, for any reason, the main avenues of fluid supply are blocked or inhibited, as in septic peritoneal intestinal stasis; nor is it necessary or essential that blood should be used in many cases when other provisional means of supplying the circulation with fluids are available. Suffice it to state that for the majority of the emergencies under consideration an artificial serum infused intravenously will meet the immediate indications by spurring the cardiovascular mechanism to renewed activity. This rally may be permanent and sufficient or it may be transitory. In either case the cannula is to remain in the vein until the issue is determined by the further course of events.

9. If after a primary massive intravenous infusion the patient relapses again into the collapsed state or it is evident that the circulation is failing, the infusion is renewed in the form of a *continuous* drip, by which the artificial serum is administered with precision and exact dosage at a rate varying, according to indications, from 40 to 60 drops per minute, or, roughly, an average of 6 ounces per hour, or 140 to 150 ounces in the twenty-four hours (4500 to 5000 cc). In this way quantities varying

from 4 to 5 liters of fluid or more, are infused directly, gradually and surely into the circulation in the twenty-four hours.

10. With increasing experience we have learned to rely prophylactically upon the intravenous drip in the very feeble, ill-nourished patients whose ability to survive an operation is doubtful. In these cases the intravenous drip is started with the operation and is continued *guttatim*, during and after the operation, as long as doubt exists as to the efficiency of the circulation. In these exceptional circumstances the intravenous drip is substituted with advantage for hypodermoclysis—the so-called "axillary sup," or for the rectal drip (proctoclysis)—since in the particularly feeble class of patients previously referred to, absorption is uncertain or likely to be long delayed.

11. The *Duodenal Tube as an Adjunct to the Continuous Intravenous Drip* is simply of priceless value. In the form of the Jutte tube, with its small bead-like tip ("sinker") and numerous perforations at its rubber terminal end, it is easily introduced through *the nose* into the stomach with little difficulty. Once in the stomach *it is allowed to remain permanently in situ* and held to the nose externally by strips of adhesive plaster. There it is kept in place as long as the gastric contents are retained or intestinal peristalsis is reversed with regurgitation of the duodenal or jejunal secretions into the stomach. This is usually the case in all obstructive or paretic states of the bowels caused by septic peritonitis and other causes. Under these circumstances the necessary nutrient and artificial sera are regularly supplied by the *intravenous drip* while the duodenal tube is also at work emptying the stomach of the foul and constantly accumulating intestinal contents. The Jutte tube, as usually supplied by manufacturers, is long enough to hang over the side of the bed below the level of the patient to permit of constant drainage of the gastric fluids by syphonage, prompted by an ordinary glass "Triumph" syringe. The tube in this way acts as a drain for the fluids and allows of the continuous escape of gases which would otherwise accumulate in quantities in the stomach. When the stomach is empty the tube is hung up

above the head of the patient and held attached to a post of the bed by adhesive plaster, leaving it open to allow the gases of the stomach to escape uninterruptedly as they accumulate.

By draining the stomach the gastric tube acts in reality as an artificial anus which empties the upper intestine of its toxic contents and diminishes the abdominal tension caused by the pent-up gases, thereby adding enormously to the comfort of the patient.

The Jutte tube passed *through the nose* does not interfere in the least with the voluntary, free and copious drinking *by mouth* of water or other pleasant, cool, refreshing drinks. The patient is thereby relieved not only of vomiting but of the intense thirst which is so distressing and peculiar to these patients. By using the tube as a syphon through the nose while the patient is drinking, the ingested fluids are immediately returned and the stomach is kept clean and the disgusting foulness of the intestinal contents is eliminated.

12. Gastric Irrigation Through a Permanently Attached Jutte Tube as a Refrigerant and Antithermic Agent. When the fever is high the temperature may be lowered most effectively by allowing the patient to drink copiously of ice water per os, or the stomach may be alternately filled and emptied through the tube with ice water many times and for as long as may be required to obtain a reduction in the rectal temperature. The stomach then serves the purpose of an ice-bag, most conveniently placed under the heart, the liver and over the aorta and vena cava, where the blood circulating in the heart and the greatest central splanchnic area of the body can be cooled directly as it is sped by the heart to the most distant peripheral regions of the body. The stomach when cooled by a continuous or intermittent ice-water irrigation serves far more effectively as an antithermic agent than any ice-bag, sponging, towelings or other cooling methods applied externally. It is superior, under these circumstances, to the cold Kemp rectal irrigation and has the added advantage of keeping the stomach clean while the patient is refreshed and comfortable. On the other

hand, when the patient is shocked, algid and hypothermic, warm or hot water can be infused into the stomach by gravity and siphoned off with no disturbance to the patient, who may be entirely unconscious of the procedure, but who is stimulated and warmed by the heat applied directly to the heart and splanchnic organs in a way that is far more effective than any external application. Of course, this central stimulation by heat in no way conflicts with the artificial warming of the exposed peripheral parts with hot-water bottles, bags, blankets, electric pads, etc., as is usual in reanimating shocked and algid patients.

13. But apart from its many uses as a gastric drain, irrigator and flue (for gases), the Jutte tube, introduced through the nose and allowed to remain permanently in the stomach, is also valuable in other surgical conditions of impoverished nutrition and exhaustion in which the early instillation of nutrient fluids *directly into the intestine* is indicated. A notable example of such an indication is afforded by advanced cases of pyloric obstruction from benign or malignant stricture, for which a late gastrojejunostomy is performed in conditions of long fasting or marasmus. In such cases it has been our practice, while performing a gastroenterostomy, to introduce a duodenal tube, previously inserted through the nose, into the jejunum for a distance of 10 to 12 cm. through the newly created stoma, where it is allowed to remain after the gastroenterostomy has been completed and until the normal gastric functions have been resumed. The tube thus introduced into the jejunum is utilized immediately or shortly after the operation as a transgastric jejunal *drip*, which supplies a peptonized glucose solution in a far more certain way than when this is administered by the usual rectal drip (proctoclysis).

The manifold uses of the Jutte tube in the surgery of the gastrointestinal canal are becoming more apparent every day as one of the most precious adjuncts to the postoperative treatment of this especially dangerous class of patients with whom we are now concerned. The growing appreciation of the value

of the tube, though referred to in several recently published contributions by gastroenterologists, is not sufficiently recognized in surgery and deserves a more extended notice.[1] I have only incidently referred to the uses of the tube in this communication because of its great importance as an auxiliary measure in the very cases in which the intravenous drip is indicated and in which we have found it most frequently applicable.

14. The Technic of the Intravenous Drip. As applied in our practice at the Touro Infirmary, the apparatus is of the simplest sort. It is precisely the same as that used for massive intravenous infusion with only a few modifications: (1) A glass graduate container of a capacity of 1 liter or more of solution; (2) a delivery rubber tube which is interrupted by interposing a tapped glass bulb (Murphy "drip bulb") which allows the nurse to observe the rate of flow and count the drops as they are delivered from the receptacle; (3) a thumb-screw clamp which controls the rate of flow; (4) a metallic cannula provided with a beaded or shouldered tip to prevent the cannula from slipping out of the vein after it has been tied in place; (5) a Duchesne's electric pad. This is a mechanical device by which intravenous infusion, hypodermoclysis and proctoclysis can be administered at a uniform temperature. The pad with its tail is light, pliable, perfectly safe, easily adjusted and always ready for immediate use, as it can be attached to an electric-light socket. It heats quickly, maintains a definite degree of heat as long as desired and the cost is reasonable. "The heating element inside the pad and tail consists of wire interspersed with strands of woven hemp. This wire is of special alloy and threadlike fineness, but is very strong. It is thoroughly insu-

[1] The value of the duodenal tube in abdominal surgery as a postoperative resource is also emphasized by the following quotation from Bassler (Southern Med. Jour., 1919, xii, 4): "If I leave no message with you, but the use of transduodenal lavage in postoperative ileus, I feel that my paper has not been in vain. Its employment is of distinct advantage and will bring happiness to you."

lated with asbestos. A platinum contact thermostat is attached so that a definite degree of heat is controlled automatically at all times when in use. The pad is 9 inches wide by 21 inches long and can be adjusted to various receptacles of various sizes and shapes by tapes attached to either end of the pad. The tail is 54 inches long, 4 inches wide, provided with snaps so arranged as to completely wrap the tubing, and the end at the cannula may be secured to the dressings which hold the arm to an extension splint or board with a safety-pin through the eyelet provided for that purpose. The outer covering of the pad and tail are of waterproof material. The device is so arranged that the heat produced in the pad will deliver the solution originally heated to 110° F., at a temperature of 100° to 102° F. when it reaches the cannula." We have found this device a most excellent substitute for the old method of keeping the solution in the receptacle and tubing warm by the use of thermos bottles and hot-water bags, which were formerly used at great cost of labor and vigilant attention and yet without obtaining the desired uniform temperature at the cannula. A description of this ingenious and carefully worked-out appliance will be found in the *American Journal of Nursing* for March, 1923, p. 470, in an illustrated article by Mary L. Duchesne, R. N.

A number of devices, more or less ingenious, simple or complicated, for the administration of artificial sera and medicated solutions by the drop method, have been utilized for proctoclysis, hypodermoclysis and endophleboclysis (intravenous infusion). Some of these aim solely at accuracy of dose; others at uniform temperature; and nearly all at both desiderata. Among these can be mentioned the apparatus of Holzbach, Friedmann, Ruebsamen and Lawen in Germany; of Thiroloix in France; of Woodyatt, Thalsheimer, Penfield, Teplinsky and Pena in America. With these we have no experience. They are no doubt valuable and meet certain special indications, but for our purpose the simple technic above described with the very practical warming device of Duchesne has satisfied all our clinical requirements.

15. In connection with the continuous intravenous drip the following points should be remembered: The cannula should have a lateral as well as a terminal opening; it should be made fast to the vein in the usual way by ligating it well over the bulbous tip; the median basilic or other prominent vein is preferred as in an ordinary temporary intravenous infusion. A glass-connecting tube should be interposed between the rubber segments of the delivery tube at a distance of 6 inches from the cannula, so that any backflow of blood or blood-stained solution should advise the operator of an obstruction at the cannula; the cannula should be immobilized and held in place by Z. O. adhesive strips, and, in addition, the terminal end of the delivery tube should be bandaged to the arm to prevent the slipping and traumatizing movements of the cannula, which would provoke the clotting of blood in the vein. For the same reason it is important that the cannula should be kept parallel with the vein and not point into its lumen at an angle. The whole arm, including the hand, should be bandaged firmly to a long, well-padded extension-board splint, and again secured to the bed or to a side table, to prevent motion of the arm in restless patients during the long period of continued instillation. In introducing the cannula the usual care should be observed to see that the solution is actually flowing from the cannula at the moment it is inserted into the vein, to avoid the sudden entrance of air. For the same reason watchful care should be observed to see that the receptacle is kept constantly supplied with the sterilized solution and that the proper drop rate is maintained. The drop count will vary with circumstances; no fixed or rigid rule can be prescribed for any great period of time. The rate of flow must be regulated by the indications furnished by the pulse.

The average rate should be about 40 to 60 drops per minute; slowed to 40, 30 or less, with an improving pulse and a rising blood-pressure. It may be increased temporarily to a continuous flow when there is greater need of stimulation, as shown by an empty, small and thready pulse.

16. Temperature. In regard to the temperature of the solution this also must vary with conditions. When the temperature of the patient is high the solution should be of an ordinary room temperature and the use of the heating device should be discontinued. When the temperature is falling or hypothermic, as shown by the rectal thermometer, the solution should be warm, at least 100° to 104° F. at the cannula, when in addition to its warming effect, a specially stimulating action upon the myocardium may be expected.

17. Air Embolism and Thrombosis. Again, in connection with the technic, it is well to state that the two great fears which have stood in the way of the more general application of the intravenous drip—air embolism and thrombosis, with the possibility of a detached clot—have no doubt been very much exaggerated. While it must be admitted that neither of these dangers is negligible and that accidents from these causes may occur, it may be stated, as a matter of fact, that they have never been observed in our experience nor in that of the many observers abroad (especially in Germany) who have recently published their observations. We have previously stated that precautions are taken against air embolism. These consist chiefly in inserting the cannula into the vein while the fluid is flowing from it, then to see that the receptacle containing the solution, is not allowed to run dry. This is precisely what is done in all cases in which a massive intravenous infusion is given; and, thus far, no accidents have been recorded from this cause in the hundreds and thousands of cases in which the procedure is currently applied in the surgical practice of all hospitals. It is quite well proven by experimentation that it is only the sudden and forceful injection or aspiration of a large quantity of air into a vein that is at all likely to be followed by embolic manifestation.

In regard to thrombosis in the vein, or at least clotting in the cannula, it may be stated that it is not an infrequent occurrence. When this happens the fluid in the cannula ceases to flow auto-

matically and the event is announced quickly by the accumulation of fluid in the counting-drop bulb in the same way that it occurs in proctoclysis. When it is evident that the obstacle is not caused by the mere obturation of the cannula by the venous wall, through displacement or angulation, the cannula should be removed and cleared of clot if this is plugging its lumen. If no clot can be detected in the vein by gently massaging it, the cannula (well oiled) is again reinserted in the same vein. If the wound is not inflamed the procedure can be repeated two or three times with safety. When the wound is inflamed, as shown by a marked areola of redness and edema of the edges of the incision, as may happen when the drip is prolonged for days, it is best to seek another vein, preferrably in the same or in the other arm. It is safer to use the veins of the upper extremity than those of the lower limbs, as the tendency to thrombosis in the legs and thighs is, relatively speaking, greater than in the upper extremity. The secret in avoiding thrombotic occlusion of the cannula or in the vein lies in the continuance of a steady drip from the cannula; as long as the solution drops at the low rate of 20 to 30 drops per minute there is little likelihood of clot formation, especially when the cannula is kept well fixed and immobilized in the arm. Our experience in this regard tallies exactly with that of Friedmann and others especially experienced in this method. One fact is certain, and that is, that in a very considerable experience in the long continued intravenous drip, in 2 cases lasting respectively five and six days, we have not had to deplore any accident from a detached embolus.

18. The Solution. What solution is to be preferred when an intravenous drip may have to be continued not only for hours but for days? Shall it be plain salt or sugar (glucose) or a complex serum? This question has been made the subject of much discussion ever since Joenischen, of Moscow, first resorted, in 1830, to saline intravenous infusion for the treatment of cholera and other dehydrating diseases. Numerous

formulæ of an isotonic or physiological artificial blood serum have been suggested by physiologists and internists long before the intravenous solutions were adopted for surgical conditions. This discussion has practically resolved itself, in modern surgical practice, to the general conclusion that for emergencies and temporary purposes the so-called normal, decinormal or physiological salt solution (NaCl, 0.7 or 0.9 per cent) is isotonic and suitable for all practical purposes as a replacing fluid. But for a long-continued instillation, glucose is the best material and should be preferred *ab initio* whenever possible. I arrived at this conclusion more than fifteen years ago following the suggestion of Friedrich, of Marburg, and Lennander, of Upsala, who resorted to glucose solutions for hypodermoclysis in septic peritonitis in 1905. When I began the practice of the intravenous drip, in 1911, I first used salt, but soon after substituted a 5 per cent glucose for the plain salt solution. Up to that time (1911) salt solution had been used exclusively in our practice. (See bibliography.)

Saline Solution. While everyone agrees that a normal or decinormal so-called physiological salt solution is isotonic with the blood and is also sufficient, for life-saving purposes in hemorrhage, to replace the lost volume of blood, its continuous intravenous administration is not without serious drawbacks and dangers. As Straub (1920) pointed out the so-called physiological salt solution is not physiological for warm-blooded animals. "He quotes Roessle to show that organic changes occur in the human heart muscle after saline infusions. In some animal experiments, Hoeszli produced tissue lesions in the heart and kidneys of guinea-pigs; lipoid droplets and fat globules appeared in the cells. These degenerative changes can be detected six to seven hours after massive saline infusions. They become most apparent in twenty-four hours and disappear in forty-eight hours. Hoeszli believes that Na ions play a decided part in the causation of these changes. Thiess pointed out, in 1910, that a healthy man needs 17 gm. of salt per day, but receives 27 gm. when given 3 liters of a 0.9 per

cent salt solution. He maintains that part of the salt is eliminated by the kidneys, but some is retained in the tissues, where it attracts liquids and causes edema." (Wiedhopf and Hilgenberg, 1923.) This is especially true in patients whose sodium chloride elimination is interfered with in acute toxic or chronic nephritis and in bronchitis or chronic cardiopulmonary diseases in which edema of the lungs is favored by salt retention. The dangers of salt retention have been too long insisted upon by the French school (Widal and Javal, 1903) and are too well recognized to be insisted upon. The effect of salt retention in disturbing the balance of osmosis and favoring dropsical accumulations are the basis of the now classical saltless diet of Widal, prescribed for the anasarca of nephritis and other dropsical diseases. Consequently, salt infusions, whether by hypodermoclysis, intravenous drip or by any other method of administration are positively contraindicated in all toxic states in which degenerative changes in the renal epithelium with salt retention occur, and also in all conditions in which pulmonary stasis from an enfeebled cardiovascular circulation predispose to hypostatic edema of the lungs.

Various formulæ have been recommended as substitutes for plain salt solution. The tendency to return to the older complex formulæ for artificial serum which were in vogue in the latter part of the last century (Hayem, Beaumetz, Jennings, Kronecker, Schmidt, Schwartz, Ringer, Locke, etc.) is shown in the recent recommendation of the normosal of Straub, and still later triple chloride of Thiess (NaCl, KaCl, $CaCl_2$), which he regards as isotonic with blood serum. The quantitative composition of this formula is: NaCl, 0.85 per cent; KCl, 0.03 per cent; $CaCl_2$, 0.03 per cent. This solution has been used for years in the clinic of Poppert, of Guisen, and other German clinics with seemingly satisfactory results. (Düttmann.) The objection to all these solutions in their application to the conditions which we are now considering lies in their chloride content and in their tendency to produce salt retention and its consequent dangers, when continued for a long period of time.

Glucose. These disadvantages and dangers do not apply to glucose. Gaule, a Swiss surgeon, was probably the first, in 1885, to substitute sugar or glucose for salt in hypodermoclysis. Friedrich and Lennander, as previously stated, advocated glucose in 1905, for hypodermoclysis. Glucose was also recommended by Kausch, in 1911, for both intravenous infusions and hypodermoclysis; and by Kuhn, in 1911–1917, as an intraperitoneal infusion, and for hypodermoclysic and intravenous use. Through the publications of these surgeons, which showed the superiority of glucose over salt in its nutritive, stimulating, diuretic and antithrombotic properties (Kuhn), I was led to the use of glucose in 5 per cent solution, which Kausch had recommended as isotonic for hypodermoclysis. Recently, Düttmann, of Poppert's Clinic, Giessen, after a very painstaking comparative study of salt and glucose solutions (he states that a glucose solution, 4.15 per cent, is as isotonic to the tissues and blood as a 0.9 per cent salt solution), concludes that the prolonged or copious administration of salt is dangerous, or at least disadvantageous, in starving or fasting subjects, not only because it leads to sodium chloride retention in the tissues, thereby favoring edema, and because of its degenerating effect upon the heart muscle and kidneys, but is also undesirable because it does not relieve the acidosis which is the invariable accompaniment of starvation.

The chief superiority of glucose over salt lies in its high nutritive food value as a foodstuff. If we roughly estimate that a 5 per cent solution of glucose is equal to 50 gm. of glucose to the liter, then 4 liters, or 4000 cc of the solution administered by the intravenous drip in the twenty-four hours, will amount to 200 gm. of glucose (about 7 ounces) in the twenty-four hours. When estimated in calories (1 gm. of glucose = 3.75 calories—Sherman), 1000 cc of a 5 per cent solution of glucose would equal 187.50 calories, and if 4 liters are administered in the twenty-four hours, 750 calories would be consumed per day.

Büdinger's experiments, quoted by Düttmann, have shown that sugar quickly disappears from the blood and causes an appre-

ciable stimulation and increase in metabolic rate, as shown in the great excretion of phosphates and urates in the urine. The body utilizes it without any residue and when introduced in isotonic solution causes no glycosuria. In our experience it is not usual for sugar to appear in the urine of patients to whom we have administered the 5 per cent solution continuously by drip for four, five or more days. On the other hand, when denser solutions have been used for diuretic purposes in infusions of from 300 to 500 cc of a 30 per cent concentration (Enriquez's solution), a slight temporary glycosuria has been observed; but solutions of this concentration are very rarely used and only when urinary suppression is threatened, especially since Guiraud's observations[1] have shown that the infusion of such solutions may be followed by serious metabolic disturbances and toxic symptoms.

My experience, as a whole, leads me to agree thoroughly with Düttmann's conclusions that an isotonic glucose solution should be preferred to saline solutions in all cases in which a parenteral supply of fluid and food is needed by fasting, shocked and exhausted subjects. Furthermore, I would add that a 5 per cent glucose solution is isotonic and is especially indicated when an artificial serum for blood replacement is to be administered for long periods of time, as by our continuous intravenous drip method. And, again, glucose is especially indicated in patients suffering from renal or cardiopulmonary lesions in whom salt retention is most dangerous.

19. Adrenalin. As an efficient adjunct to glucose solution in stimulating the myocardium and in raising the blood-pressure we depend upon adrenalin, 1 to 1000 solution. It rightfully claims the first place in artificial stimulation by the intravenous route when injected cautiously as needed, in accordance with the indications furnished by the pulse and blood-pressure. The adrenalin solution is injected, drop by drop, with a hypodermic syringe, the needle being inserted, by the Crile method, directly

[1] Paris méd., July 25, 1914.

into the delivery tube near the cannula. One drop is injected at a time and the effect carefully noted. If the usual marked effect in improving the pulse is observed, the adrenalin is discontinued. As a rule, not more than 5 to 10 drops are injected at a time in series. The adrenalin is repeated only according to indications furnished by the pulse and blood-pressure. Usually after a decided effect is obtained by the adrenalin the continued glucose drip suffices to maintain the improved quality of the pulse.

We have seen no advantage in the continued administration of the adrenalin as a permanent infusion mixed with the glucose solution. In Germany, a great deal of stress is laid upon the continuous administration of the adrenalin, and it is given mixed with the salt solution (which is still used in most clinics) in the proportion of 1 cc of the 1 to 1000 adrenalin to the liter of the normo-sal solution. (Wiedhopf and Hilgenberg.) In our practice the intern or nurse is instructed to administer the adrenalin only when the pulse is growing more rapid and shallow. The main reliance is placed upon the stimulating and blood-replacing effect of the glucose solution alone when it is continuously applied by the drop method. Other drugs, such as pituitrin, morphine, the soluble digitalis preparations, strychnine and caffeine are administered by injecting them directly into the rubber tube which delivers the glucose solution into the circulation. Camphor oil we use frequently, but only subcutaneously.

Oxygen. We have had no experience with Küttner's suggestion that the solution used for an infusion can be improved by oxygenating it. On the basis of his experiments, 1 liter of normal saline solution can take up and hold 20 cc of O_2. This suggestion strikes me as rational and well worthy of consideration, but in the conditions in which we have resorted to the continued intravenous drip we have not found it practical to extemporize the oxygenated solution, though it would appear quite feasible to prepare it in prolonged cases. Presumably glucose solution could be saturated with oxygen as well as salt

solutions, but it will require further experimentation and clinical experience to determine its practical advantage.[1]

20. Results. Wiedhopf and Hilgenberg, operating for septic peritonitis from various causes in Läwen's Clinic (Marburg), applied the intravenous drip in 52 cases which had been recorded in that clinic during the last two years (up to the date of their publication, in 1923). They used saline solution (Straub's formula) in combination with adrenalin in the proportion previously stated. Ten of these patients died within the first twenty-four hours. These patients were regarded as inoperable, practically moribund, but the operation was risked in spite of the bad prognosis; presumably the improved circulation obtained by the drip justified the intervention. In 25 cases the collapse was caused by peritonitis. The majority of the cases were infused ("dripped") after operations for peritonitis caused by appendicitis; a few were perforating gastric ulcers or ruptured gall-bladders. Postoperative failure of the circulation was the chief indication for the intravenous drip in 19 cases. The total mortality and causes of death are not stated.

My personal experience with the intravenous drip, though it goes back to 1911, does not exceed 26 cases. We began, as previously stated, with saline solution, 0.7 per cent, but after the first few cases we substituted glucose, 5 per cent, and have continued this solution to the present time. In the beginning and up to the last few years we resorted to the intravenous drip only in very exceptional, unusual and desperate cases. More recently, as our experience has increased and we have gained more confidence in its safety, we have enlarged its field of application and applied it with greater frequency. Owing to this exceptional and restricted use to the gravest cases, the total mortality has not been less than 60 per cent. The comparatively

[1] Friedemann (Zentralbl. f. Chir., 1921, No. 4, p. 114) has put in practice Küttner's suggestion and described an ingenious electric-heating apparatus to which is attached an oxygen cylinder. A stream of the gas is run through a normal saline solution in the warmed receptacle. He has applied this successfully in one case of ruptured tubal pregnancy, the solution being infused for nine hours by the intravenous drip method.

small number of cases in which the method has been applied in our clinic is accounted for by the fact that the majority of our cases have been treated for conditions for which the usual methods of proctoclysis, hypodermoclysis or a single intravenous infusion or blood transfusion have sufficed to meet the immediate indications. In a large emergency hospital or ambulance service the indications for intravenous drip would be, I am sure, enormously increased, to the great advantage of the patient.

I regret that I have not been able to tabulate the number of cases treated in my service with all the details necessary for an accurate report, but I am gathering all the available records of patients operated by myself and other colleagues who have adopted the method, with the expectation of the early publication of a detailed report. Suffice it to say that in the extremely grave and complicated (and too often hopeless) cases in which I have resorted to the drip in the past the mortality rate is necessarily very high and that the failure of the drip to save life is no criterion of its efficiency or inefficiency except for the particular purpose for which it is applied. In addition, the proper and safe application of the intravenous drip for protracted periods of time demands the constant and vigilant attention of thoroughly intelligent and competent attendants who are not always available. A few examples would suffice to show that in spite of a revived circulation, well sustained by the intravenous drip, death will inevitably occur when irreparable damage has been inflicted upon the organism in any of its vital parts. For instance:

A man, aged fifty-one years, was admitted to my service at the Touro Infirmary in April, 1913, suffering with a strangulated inguinal hernia. I had to resect two feet of gangrenous gut. The continuity of the resected bowel was restored by a circular enterorrhaphy. The patient recovered from the operation and was improving, when he developed an acute gangrenous cholecystitis which had been latent for years. The gall-bladder was promptly drained and two calculi removed. The gall-bladder

had perforated and a quantity of pus and bile had escaped into the peritoneum. An intravenous drip was instituted and the patient rallied and was seemingly recovering after consuming more than 8000 cc of glucose solution. On the fifth day, however, he suddenly developed cerebral symptoms and died in profound coma. The postmortem revealed a large cerebral abscess which had ruptured into the lateral ventricles, flooding them completely with foul, colonic pus. Here the circulation was well maintained up to the last few hours before death.

In another instance, a woman, aged thirty-two years, suffering from an obstructing rectal carcinoma, was operated on June 10, 1922. An artificial sigmoid anus was created as a preliminary to a radical amputation of the rectum. The operation presented no unusual features and the postoperative sequelæ were uneventful until the fourth day, when she suddenly collapsed, with excruciating pains in the abdomen and signs of acute intestinal obstruction. The circulatory collapse in this case was profound and death seemed imminent. A glucose intravenous drip was started at once and the patient warmed up and rallied promptly. The abdomen was then opened and a coil of gut, representing the greater part of the jejunum, was found strangulated in the left paraduodenal fossa of Treitz. The gut was extracted with great difficulty from this pouch, and when exteriorized was found to be cyanotic, purple and with a number of suspicious spots suggesting the beginning of necrosis. By pouring pitchers of hot salt water over the gut the color and motility improved sufficiently to justify us in replacing it in the cavity. The artificial anus at the sigmoid, made five days previously, was now functioning actively and discharging quantities of gas and fluid feces. Through this ordeal the pulse was remarkedly well sustained and gave us no anxiety, the intravenous drip continuing uninterruptedly all the time. Nonetheless, and in spite of the remarkably good pulse, the patient died on the fifth day. Death had been caused by mesenteric thrombosis and consequent gangrene of the gut in patches.

In this case the patient consumed in six days, beginning with the collapse, 14,800 cc of a 5 per cent glucose solution, or nearly 15 quarts, of which 2000 cc were of 0.7 per cent saline, all administered by the intravenous drip with the intermittent addition of adrenalin drops, as these were specially indicated. In this case the drip more than filled our expectations in holding up the circulation to a remarkable degree. Toward the end, while the pulse held well, the respiration became shallow, intermittent and failed before the pulse gave way. No wonder that under such overwhelming sepsis the most effective support to the circulation was of no avail. In this case the Jutte tube in the stomach was of immense service in preventing vomiting and keeping the patient comfortable by constant gastric lavage and drainage.

On the other hand, the value of the intravenous drip as a life-saving measure is shown in a more favorable light in the following case:

A farmer, aged forty-eight years, tall, profoundly anemic, almost marasmic from long fasting and intestinal hemorrhage, was referred to me in April, 1918, with a diagnosis of duodenal or gastric ulcer. He had been in the infirmary scarcely two days while undergoing preparation for operation, when he developed all the signs of an acute peritoneal collapse. The abdomen was promptly opened and a perforating ulcer of the first portion of the duodenum was recognized. The extravasated duodenal contents were carefully wiped out and the perforation closed by suture of the partially excised and inverted edges. A single massive intravenous glucose infusion rallied the patient and he seemed to be recovering, but on the fifth day signs of suppuration in the right hypochondrium with diaphragmatic pleurisy appeared. The patient, who had been dieting for many months before the operation, was exhausted and extremely emaciated. At this juncture his pulse began to show signs of a progressive and alarming weakness. A continuous intravenous

drip was now instituted, and following its good effect a large collection of pus was drained from the subphrenic space by a transpleural thoracotomy; to do this effectively the ninth and tenth ribs had to be resected. The patient could now scarcely nourish on account of the constant regurgitation of the gastric contents. His anal sphincter was too weak to retain the rectal drips and systematic hypodermoclysis failed to improve his circulation. The continued intravenous drip gave us the only hope to supply him with fluids and food, and after this had been instituted it was allowed to continue unremittingly for five days, when he began to retain water and nutritive fluids by mouth. The pulse, which had been reduced from 140 to 150 to 110 by the drip, then continued to retain its good quality after the drip had been temporarily interrupted to test the improved stability of the pulse. In view of the continued improvement of the pulse the cannula was removed from the vein and the drip permanently discontinued. During the five days that the drip had been in operation the patient had consumed 22,000 cc of glucose solution. The patient finally recovered after a long convalescence. He returned on June 22, 1920, with a cicatricial stricture of the duodenum, which was completely relieved by a posterior gastroenterostomy. He has since been heard from, expressing himself as perfectly well and attending to his usual occupations. In this case blood transfusion was indicated even before the perforation of the duodenal ulcer had occurred, but it is doubtful that it would have had the permanent stimulating and nutritive effect that the continued glucose drip exercised during the prolonged period of exhaustion and gastric intolerance for food and drink that this patient displayed after the operation.

In another and more recent case the intravenous drip carried the patient through a critical period of collapse from hemorrhage and permitted a Cesarean section to be done, with recovery without recourse to blood transfusion:

Mrs. F., primipara, aged twenty-five years, was admitted to the Touro Infirmary on July 15, 1923. She had arrived nearly at term, but was suffering from frequent and copious hemorrhages caused by placenta previa. Efforts to dilate and deliver by podalic version had been made by her attending physician, Dr. F. Larue, but the deluge of blood that followed compelled a hasty tamponade, which had to be renewed on account of the constantly recurring hemorrhage. It was decided that a Cesarean section was necessary, but the patient was so bleached and collapsed from hemorrhage and exhaustion that we proceeded with an intravenous glucose drip, pending the typing of the husband's blood preliminary to transfusion. The transfusion, however, was postponed and not carried into effect, as it was not found necessary. The pulse was steadily growing weaker and the hemoglobin had fallen to 60, then to 50 per cent. Under the influence of the continuous intravenous drip the pulse improved and we were able to deliver a dead fetus without great difficulty. The cannula was allowed to remain in the vein and the drip was continued all that day, when the pulse and general condition had improved so much that the drip was discontinued. In the course of twelve hours the patient had received 3800 cc of 5 per cent glucose with several intermittent additions of pituitrin and adrenalin. She was fortunately able to nourish and drink by mouth, and in this way made an excellent recovery and was discharged well, though still slightly anemic, twenty-one days after her delivery.

In this case the glucose drip allowed us to dispense with what seemed at first to be a necessary blood transfusion.

The preceding cases, which have been merely sketched in outline are quoted to illustrate the class of patients in whom we have resorted to the intravenous drip, but they could be multiplied many times over if space would permit a detailed account of the 26 patients in whom we have found this measure specially indicated. In view of the desperate character of all of them, it is not surprising that fully 60 per cent succumbed to the primary

or secondary causes that brought the patients to the operating table. If the continued intravenous drip had been used as a routine method in the class of patients in whom we still use proctoclysis, hypodermoclysis or massive infusion or transfusion the intravenous drip would indeed make a most brilliant showing. Thus far we have limited the application of this method to the cases in which other procedures requiring less vigilance, prolonged attention and intelligent discretion on the part of the attendants suffice, ordinarily, to meet the indications. There is no reason why the intravenous drip should not be extended with advantage to a far greater number of indications provided competent assistance is available.

In conclusion, allow me to repeat that for certainty of dosage, promptness and duration of effect in sustaining a weak or failing circulation none of the methods of cardiovascular stimulation at present in vogue can compare with the continuous intravenous drip. When glucose is made the basis of the infused fluid, the continued intravenous drip is incomparably superior to all the other methods of parenteral nutrition and medication, as it supplies continuously an easily assimilated foodstuff in isotonic solution for an indefinite time. In this way, it serves the purpose of a blood-replacing and nutrient fluid, constantly supplied; in addition it is a cardiovascular stimulant, a diluent (of toxins and catabolic products), an eliminant (especially by the renal route) and a neutralizer of the acidosis which is present and so often adds to the dangers which beset the precarious existence of the patients now under consideration.

References on Intravenous Drip

Düttmann, G.: Bruns' Beiträge, 1923, No. 1, cxxviii, 68.

Friedemann: Zentralbl. f. Chir., 1913, p. 1893; Deutsch. Ztcshr. f. Chir. 1919, cli, 352; Zentralbl. f. Chir., 1921, p. 114.

Friedrich: On Artificial Subcutaneous Feeding in the Practice of Surgery, Langenbeck's Archiv, 1904, vol. lxxiii; Trans. First Int. Cong. Int. Soc. Surg., Brussels, 1905, p. 10. (Discussion on the Treatment of Peritonitis.)

Godaud: La cure de dechloruration, Thèse de Paris, 1904.

Kausch: Deutsch. med. Wchnschr., 1911, No. 1; ibid., 1917, No. 25; München. med. Wchnschr., 1916, No. 15.

Kuhn: Deutsch. Ztschr. f. Chir., 1913, cxxii, 90.

Lennander: Discussion on Peritonitis, Trans. First Int. Cong. Int. Soc. Surg., 1905, p. 38.

Matas, R.: A Clinical Report on Intravenous Saline Solution in the Charity Hospital, New Orleans (1881–1891), New Orleans Med. and Surg. Jour., July-August, 1891.

Penfield, W. G., and Teplinsky, D.: Archives of Surgery, 1923, No. 1, vol. vii, p. 111.

Thalheimer, W.: Jour. Am. Med. Assn., 1922, lxxviii, 190.

Thiroloix, M. J.: Bull. et mém. Soc. méd. des hôp. de Paris., December 7, 1922, 3d series, p. 34.

Unger, E. and Heusser, H.: Thérapie d. Gegenwart, 1923, lxiv, 15–18.

Widal and Javal: Bull. de la Soc. méd. des hôp. de Paris, June 26, 1903.

Wiedhopf, O. and Hilgenberg, F. C.: Bruns' Beiträge, 1922, No. 1, vol. cxxvii.

(A valuable list of references to the German literature on the continued drip *is given in the last article.*)

References on Gastric and Transgastric Intubation Applicable to Surgical Practice

Bassler: Southern Med. Jour., 1919, xii, 4.

Carnot and Liebert: Paris méd., 1922, No. 13, vol. xii.

Heller, E. P.: Therap. Gaz., Detroit, 1922, xxxviii, 461.

Jutte, M. E.: Jour. Am. Med. Assn., 1913, lx, 586, 687; Am. Jour. Med. Sci., 1917, cliii, 732.

Levin, A. L.: Southern Med. Jour., July, 1920, No. 7, vol. xiii.

Oden, C. L. A.: Surg., Gynec. and Obst., 1923, xxxvi, 572.

SPECIAL POINTS IN GALL-BLADDER SURGERY

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The outstanding problems of gall-bladder surgery remain practically unchanged with the passing years. In this paper, therefore, I shall confine myself to a discussion of certain present opinions which are based upon the experience of my associates and myself in 1235 operations on the gall-bladder, among which the records of 886 operations are available for detailed study.

Diagnosis. As in the diagnosis of hyperthyroidism, of cancer of the stomach, of nephrolithiasis and of appendicitis it is not the frank, typical case which challenges us, but the case with vague, disquieting, sometimes acute, often chronic symptoms which, while perhaps they simulate most closely those of a cholelithiasis or cholecystitis, may refer to the stomach, the kidneys, the appendix or the pancreas. In some cases stones may be promptly and clearly defined by a roentgenogram; or the outline of a thickened enlarged gall-bladder may be visible. In others the diagnosis, as far as the roentgenogram is concerned, is based upon the presence of abnormalities in adjacent organs, and in many cases series of plates are required. It has been our experience that our percentage of correct preoperative diagnoses increases in direct relation to the amount of study which is devoted to the case by our roentgenologist.

As to the diagnostic value of the Lyon test we agree with Fitz,[1] of the Mayo Clinic, that "it seems doubtful whether much

[1] Fitz and Aldrich: Clinical Observations on Certain Constituents of the Bile, Jour. Am. Med. Assn., 1922, lxxix, 2199.

diagnostic significance can be attached in the clinical study of cases to similar analyses of bile, the specimens of which are collected through the duodenal tube by Lyon's method, and at best by an indirect route from an undetermined source in the biliary tract."

Whatever diagnostic aids are utilized, however, and in uncertain cases these should include all the measures at our command, it should be emphasized that, as in the differential diagnosis of hyperthyroidism or of appendicitis, final dependence must be placed upon clinical judgment.

In certain cases, however, despite the most complete history, despite a painstaking physical examination, despite the aid of the roentgenologist, despite chemical analyses, and even despite a direct examination through a right rectus incision, the correct interpretation is not made. The one final criterion, therefore, is the end-result.

MANAGEMENT. The management of cases of gall-bladder disease, which includes the type of operation, is strictly individualized.

In general, we have followed the lead of the Mayo Clinic as to cholecystectomy, and it has been our experience that this method yields the higher percentage of postoperative symptom-free results; our changing opinion regarding the relative values of cholecystectomy and cholecystostomy is indicated by the fact that although our total statistics show 43 per cent of our series were cholecystectomies and 57 per cent cholecystostomies, during the years 1917 to 1922 inclusive this relation was reversed, 84 per cent of the later series being cholecystectomies as opposed to 16 per cent cholecystostomies.

Nevertheless, in a certain group of cases cholecystostomy bears a lesser mortality. Therefore, in patients with high blood-pressure and interstitial nephritis, in the aged and in obese patients and in severely jaundiced patients the lesser operation is performed.

In emaciated, jaundiced, depressed cases a slow intermittent decompression by means of a fluid-tight drainage system is

important. This maneuver is comparable to that employed by urologists in cases in which the urinary bladder is distended.

In a jaundiced case in which the gall-bladder is a shrunken mass of scar tissue containing no bile, while the common duct is dilated, decompression is accomplished by drawing off most of the bile with a syringe, opening the duct to remove any stones which may be present in the immediate field and establishing a rubber tube fluid drainage, with an abundance of drainage just below the point of common-duct drainage.

The point of prime importance in the case of a greatly depressed patient is the performance of the minimum amount of surgical trauma needed to establish drainage. After the utmost possible degree of restoration has been accomplished by blood transfusion, hypodermoclysis, hot packs, rest, the further operative procedures may be performed with lessened danger. It should be borne in mind that morphine is contraindicated in these cases because of its specific depressing effect upon the liver.

In all operations upon the gall-bladder the control of infection is of paramount importance, of more importance even than in the case of operations within the pelvic cavity or in the lower abdomen, for within the upper abdomen the defence against infection is weaker than in the lower abdomen. Surprisingly active infection, therefore, may follow very slight soiling by the infected contents of the gall-bladder or ducts. The best measures of prevention are an ample exposure and an adequate preliminary packing with gauze so complete that not a pad will be changed during the operation. Even when every possible precaution has been taken we occasionally encounter a leakage of bile. For this reason I still hesitate to close without drainage.

In our experience a high Bevan incision serves best both for an ample exposure and for the postoperative restoration of a sound abdominal wall. In cases in which the condition of the patient demands the minimum primary operation, *i. e.*, the establishment of drainage and no more, a very short incision immediately over the gall-bladder and the insertion of the drainage tube constitute almost a minor operation. In every case

it is important to exercise the utmost care to prevent the slightest tear or cut into the liver substance.

In an occasional case of prolonged severe jaundice associated with infection a fatal hemorrhage may occur in spite of calcium and repeated blood transfusions. In one such case six donors were used, giving a total of 3800 cc of blood, and calcium was used both before and after operation without avail.

STATISTICS. It is difficult or impossible in this as in other fields satisfactorily to compare the statistics of many reporters because of the variations in the form of their presentation. The following figures culled from the literature, however, are of special interest in their bearing upon the cholecystectomy against cholecystostomy controversy:

ERDMAN, 1910.
Operative Mortality: Cholecystectomy, 4 per cent; cholecystostomy, 4.2 per cent.

TRUESDALE, 1921. (Exclusive of carcinoma.)
Operative Mortality: Cholecystectomy, 2.3 per cent.
End-results: Cholecystectomy: Cured, 89 per cent; improved, 6 per cent; not improved, 5 per cent. Cholecystostomy: Cured, 55 per cent; improved, 32 per cent; not improved, 13 per cent.

GOODWIN, 1921.
Operative Mortality: Cholecystectomy, 3.3 per cent; cholecystostomy, 5 per cent.
End-results: Cholecystectomy: Cured, 88 per cent; improved, 9 per cent; not improved, 3 per cent. Cholecystostomy: Cured, 71.5 per cent; improved, 23 per cent; not improved, 5.2 per cent.

HOMANS, 1920.
Operative Mortality: Cholecystectomy, 5.3 per cent.
End-results: Cholecystectomy: Cured, 77 per cent; improved, 19.4 per cent; not improved, 3.6 per cent.

MOORE, 1921.
Operative Mortality: Cholecystectomy, 5 per cent; cholecystostomy, 5 per cent.
End-results: Cholecystectomy: Good, 70 per cent; fair, 20 per cent; bad, 10 per cent. Cholecystostomy: Good, 40 per cent; fair 45 per cent; bad, 15 per cent.

C. H. MAYO, 1921. Results not divided as to type of operation. Series from January, 1907, to August, 1920. 7688 cholecystectomies, 3346 cholecystostomies.
Operative Mortality (1744 cases): 2.2 to 2.4 per cent.
End-results: Cured, 60 per cent; greatly improved, 30 per cent; less improved, 10 per cent.

In our own series, among a total of 1235 operations upon the gall-bladder and gall ducts, the mortality rate has been—

Cholecystectomy	2.5 per cent
Cholecystostomy	5.4 "

Although these figures make it appear that cholecystectomy is the safer operation, this is due to the fact that cholecystostomy is used in the "bad risk" cases.

SUMMARY. The points of prime importance in the surgical management of gall-bladder diseases may be briefly stated as follows:

1. Strict individualization of the patient.
2. Restoration and maintenance of the internal respiration of the cells.
3. Decompression only, in extreme cases.
4. Special precautions against infection.
5. Drainage to prevent possibility of postoperative infection from leakage.
6. The criterion for choice between cholecystectomy and cholecystostomy is the condition of the patient.

THE COEXISTENCE OF CHOLECYSTITIS AND DUODENAL ULCER IN THE SAME CASE, WITH THE REPORT OF SEVERAL RECENT CASES.

By ARCHIBALD MAC LAREN, M.D.

AND

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(By Invitation.)

Supposing the septic theory of duodenal ulcer to be correct, then the coexistence of cholecystitis and duodenal or gastric ulcer stands upon the same foundation as that existing between appendicitis and inflammation of the gall-bladder.

Postmortem findings, as quoted by Judd, go to prove that a healed duodenal ulcer is frequently found in patients who give no past history of digestive disturbances. Just because a patient has gall-stones does not prove that they are the cause of the patient's symptoms. Every abdominal surgeon recognizes the fact that slumbering gall-stones may exist for years without producing any symptoms.

The following 5 cases occurring in the past few months seem worth recording for the purpose of drawing attention to the combination of cholecystitis and duodenal ulcer. While no formal record has been found in the literature for the past few years, we find in the report of a clinical lecture delivered by Oschner that he has noted on several occasions the occurrence of these two diseased conditions in the same patient.

Case I.—Patient with a definite duodenal ulcer history; gall-bladder removed by another surgeon one year before without relief of symptoms.

P. E. J., male, aged forty-five years. Patient of Dr. H. Perrin.

Past History. Eight years ago patient began to have symptoms of gastric disturbances, one or two hours after eating, with vomiting. Later he had attacks with food relief and much gas, coming every three or four months and lasting ten days or more. In November, 1921, he was operated upon, at Eau Claire, Wisconsin, for cholecystitis and his gall-bladder was removed, bringing no relief.

Present Illness. Symptoms of gastric distress have come on gradually. One month ago he vomited and became afraid to eat on account of marked discomfort.

FIG. 1.—Case I. Perforating duodenal ulcer seen at "x." Barium remained in this pocket for twenty-four hours after barium meal.

Physical Examination. Tender spot over the pylorus on fluoroscopical examination. *X*-ray plates showed a perforated base of an old duodenal ulcer with retained barium for many hours after a meal.

Operation. September 14, 1922. St. Luke's Hospital, ether anesthesia. On opening the abdomen, adhesions were found between the liver and the anterior abdominal wall. The gall-

bladder had been removed fourteen months before. A chronic indurated ulcer of the posterior wall of the duodenum was found, with no evidence of pyloroplasty or excision at the time of the previous operation. A short loop posterior gastroenterostomy was done and the patient made an uninterrupted recovery, and reported to us two months later that his digestion was perfect and that he had gained 10 pounds.

Case II.—Chronic obstruction from duodenal ulcer and chronic cholecystitis, with one large stone.

T. B. O'B., female, aged fifty-eight years, married.

Family History. Negative.

Past History. Hay-fever for the past twenty-seven years; otherwise always well until the present illness. Menopause five years ago.

Present Illness. In April, 1921, patient began to have what she describes as attacks of "stomach trouble." The first attack came on suddenly with a chill, severe nausea and vomiting of a more or less tasteless, watery fluid. The vomiting continued almost constantly for six weeks without any jaundice or pain, but she became weak from lack of nourishment. In the fall of 1921, she had a similar attack, but of shorter duration. During the following year there were several such attacks, always with nausea and vomiting, but no pain. In September, 1922, the attacks became very severe and she vomited continuously and became hysterical. As before there was vomiting without pain or jaundice. Vomitus consisted only of a watery fluid. Between these various attacks she has had a good appetite and has eaten everything because, as she says, food apparently was not a factor in her attacks. She first consulted us on October 25, 1922, in a quiescent period, and was placed in the hospital under observation and remained for four days. *X*-rays of the gall-bladder, kidneys and ureters were negative, as were all the routine laboratory findings. She was sent home with instructions to report at the office for further observation, but nothing was heard from her until November 22, 1922. During this interval

there had been three attacks of chills, nausea and vomiting of about three days' duration each. During these attacks there was no pain but a feeling of tenderness midway between the shoulder blades.

FIG. 2.—Case II. Ulcer crater shown by arrow. Gall-stone not seen in picture because it is a transparent cholesterin stone.

Physical Examination. A rather obese individual with evident recent loss of subcutaneous fat. Except for a complete procidentia the findings were negative. Blood-pressure, 140/80. Urine negative. Ewald meal: Free HCl, 58; total acidity, 94; microscopical and chemical examination negative. Fluoroscopical examination of the stomach showed a definite constant filling defect in the duodenal cap verified by plate studies. A diagnosis of duodenal ulcer was made.

Progress. The patient was put to bed in the hospital and placed on a rigid diet of 800 cc of milk in twenty-four hours for six days, with feedings on the even hour and alkaline powders on the half-hour. She complained constantly of a feeling as if there was a lump under the manubrium at the level of the

third rib, and although she had no attacks, she apparently did not improve, and on December 9, 1922, an operation was advised.

Operation. Ether anesthesia was given and on opening the abdomen dense adhesions were noted in the gall-bladder region. The gall-bladder was thickened and indurated and contained one large stone. Cholecystectomy was performed. There was a marked induration and thickening along the posterior wall of the duodeum from an old chronic ulcer. This induration extended just beyond the pyloric vein and produced a partial obstruction. A posterior gastroenterostomy, using a short loop, was performed and a drain placed at the stump of the cystic duct and the abdomen closed. The operative diagnosis was cholelithiasis and duodenal ulcer.

Postoperative. Convalescence was uneventful. The patient lost the "lump" on the second day and says she has not felt so well for years.

Subsequent History. On going over the entire past history after the operation the patient recalled that about eleven years ago she had had a short period in which she was troubled with indigestion and gnawing in the stomach just before meal time, but that it soon passed away.

Case III.—Patient with definite digestive attacks occurring every few months for the past five years.

A. B., male, aged thirty years, single.

Family History. Negative.

Past History. Scarlet fever in 1900; diphtheria in 1910; no sequelæ. Ruptured appendix in 1913, drained and wound not closed.

Present Illness. During 1918, had two or three attacks of what he describes as "tightness in the chest," lasting about two or three hours. These attacks came on at various times and had no apparent relation to meals. During 1919, he felt perfectly well. Early in 1920, there were several attacks similar to those in 1918. Beginning in November, 1921, the attacks became more and more frequent, and there was a pressure sense

in the upper abdomen but no pain or nausea. In February, 1922, the attacks became severe, occurring every ten days, with pain radiating from the upper abdomen to both shoulder-blades. The duration of the attacks never exceeded two hours. He vomited only once, and that with one of the last attacks. Vomitus was watery and very sour. Stools have been loose all the time since the beginning of the attacks in 1918.

FIG. 3.—Case III. A cluster of gall-stones probably of the slumbering variety. Duodenal ulcer probably present but not proven.

Physical Examination. A well-developed and nourished individual. Abdomen showed a weak abdominal scar in the right lower quadrant with a slight hernia in the upper angle. There was tenderness on deep pressure in the midepigastrium. The balance of the examination was negative. Blood-pressure, 125/75. Urine, blood and stools were negative. *X*-ray plates showed a large cluster of gall-stones. A diagnosis of cholelithiasis was made and an operation advised.

Operation. May 16, 1922. On opening the abdomen there were marked adhesions in the region of the gall-bladder, and

the gall-bladder was firmly adherent to the under surface of the liver. Cholecystectomy was performed. The gall-bladder contained eight stones the size of hazel-nuts and thirty smaller stones. Convalescence was uneventful. There is no record of exploration of the stomach or duodenum. Operative diagnosis: Cholelithiasis.

Subsequent History. June 13, 1922, one month after the operation, the patient reports a return of distress in the midepigastrium about as before his operation. There is a soreness a little to the left of the median line which is noticed especially just before breakfast. Fifteen minutes before eating there is only a sensation of a "lump" in the stomach. This gradually wears away until just before noon, when he says he feels hunger pain, and again just before dinner in the evening. Bowels are still loose.

Physical Examination. A little tenderness on deep palpation in the midepigastrium, otherwise the examination was negative. Urine negative; no white count made; stools not examined. Ewald meal: Free HCl, 40; total acidity, 48. Fluoroscopical examination shows an apparently normal stomach. Duodenal cap pulled posterior and rather fixed; probably adhesions; no definite filling defect, although the cap is not symmetrical. Plates do not show the cap very well, probably because of its posterior position.

Patient was placed on a modified Sippy diet and reports that he is getting only slight relief.

Case IV.—Combination of cholecystitis and cholelithiasis with many stones and an indurated duodenal ulcer with complete inflammatory obstruction of the pylorus. Patient slowly starving to death.

J. H. S., female, aged sixty-one years, widow.

Past History. Negative. Menopause five years ago.

Present Illness. In the winter of 1921–1922, she had a fall while getting out of an automobile and was sick in bed three months, during which time she was on a milk diet. Shortly

after the accident she began to vomit and on one occasion vomited a small amount of blood and had a dull pain in the epigastrium. The vomiting continued off and on for some weeks and then stopped. No bloody or tarry stools had been noted. During the summer of 1922, she felt perfectly well, but in the fall began to be constipated and had occasional vomiting spells. Once in September, 1922, the vomitus contained a small amount of blood. A local doctor washed out her stomach a good many

FIG. 4.—Case IV. Gall-stones at "x." Pyloric end of stomach ragged and irregular with no duodenal cap and almost complete retention of barium meal given twenty-four hours previously.

times and she took some white powders. Since September she has had a constant dull pain in the epigastric region, apparently without relation to meals. Has lost about 20 pounds in weight in the last six weeks. Comes in now because of stomach distress, persistent vomiting and a palpable mass in the pyloric region, which she has noticed for at least six weeks.

Physical Examination. A poorly nourished woman with a dry skin and drawn face. Heart and lungs negative. Abdomen

sunken, spasm in right upper quadrant with a distinct mass about the size of an orange, which is slightly tender and slightly movable. *X*-ray shows a large low stomach, lower pole at the symphysis, but otherwise normal. Duodenal bulb irregular in outline and very irregular in its course. Apparently an extrinsic mass which is slightly movable, but does not descend during inspiration and presses on the duodenum. Plates also show multiple gall-stones. Twenty-four-hour fluoroscopic shows almost complete retention of the barium meal. Ewald meal: 1000 cc; free HCl, 42, total acidity, 73; lactic acid, 0; blood, 0.

Operation. Entirely under local anesthesia and without any pain. On opening the abdomen there were marked adhesions between the gall-bladder and duodenum and a large inflammatory mass in the duodenum from an old indurated ulcer. Gall-bladder thickened and full of stones. Posterior gastro-enterostomy was performed. The gall-bladder full of stones was not disturbed. A report on a piece of tissue removed for microscopical examination was as follows: "Tissue lymph node showing hyperplastic changes as would be expected in a node draining a field of chronic inflammation. Temperature never over 99, while at the hospital, except on the day of admission when it was 100. The patient gained 30 pounds in the hospital and made a perfect recovery."

Case V.—Cholelithiasis with a healed duodenal ulcer.

H. S., female, aged fifty years; patient of Dr. J. MacLaren.

Past History. When the patient was twenty-eight years old she had a sudden hemorrhage from the bowels, and for the next six months had a marked duodenal ulcer history, but no symptoms of duodenal ulcer since that time.

Present Illness. Dates back nine years, at which time she had a typical gall-bladder attack with very severe pain lasting fourteen hours. Later had a second attack, also very severe. The third attacks was three months ago, lasting all night, followed by jaundice.

Operation. Showed a healed duodenal ulcer with no induration or obstruction. Chronic cholecystitis and a small shrunken, thickened gall-bladder with one stone the size of a hen's egg and three smaller stones. There was an enlarged fibroid uterus. The gall-bladder was removed and nothing was done to the duodenal ulcer or to the fibroid uterus. The patient made a good recovery.

Conclusion. It is our conclusion that when operating for gall-bladder disease, especially in the presence of gall-stones, that we should also carefully examine the stomach and duodenum to be sure that a duodenal or gastric ulcer does not exist at the same time.

FURTHER OBSERVATIONS ON THE USE OF THE CAUTERY IN PEPTIC ULCER

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In 1914, I proposed the use of the cautery for the excision of certain types of peptic ulcer. Since then we have employed the cautery in 725 cases of peptic ulcer. This experience has shown us the types of ulcers to which the cautery is most applicable, the contraindications to its use, the most effective way of utilizing it, the risk of the operation and its end-results. It is upon these points that this series of 725 cases will be reviewed.

Gastric ulcers may, for our purpose here, be arbitrarily divided into three groups: (1) Those in which the crater is 1 cm. or less in diameter, (2) those between 1 and 2 cm. and (3) those over 2 cm. The cautery was first suggested for the first group, since it was commonly observed that, after knife excision of such small lesions, the remaining opening was out of all proportion in size to the lesion removed, and it seemed that some method might be devised to avoid this disadvantage. Ninety per cent of all gastric ulcers involve the lesser curvature, and since a large percentage are small the cautery has a wide applicability.

The method originally proposed for cautery excision of these small ulcers has been followed; that is, reflection of the gastrohepatic omentum exposing the peritoneal aspect of the ulcer, and accurate location of the crater of the ulcer by palpation, the perforation of the center of the crater by a Paquelin or electric cautery, continuing the burning until the crater is completely

destroyed, closing the opening by chromic catgut sutures, and following this procedure with a gastroenterostomy. The opening to be closed is, therefore, not larger than the crater itself; it is closed with ease and in the entire series of cases there has been no evidence of leakage. The success of the operation is, of course, dependent on the accurate localization of the crater of the ulcer, and it should be emphasized that the crater of the so-called lesser curvature ulcer is seldom on the lesser curvature —it is usually on the posterior wall.

Ulcers with medium-sized craters—that is, between 1 and 2 cm. in diameter—may be malignant without visible evidence. Because of this possibility, the crater should be exposed to view by opening the stomach and an excision made by the cautery knife, as suggested by Sistrunk. The portion of the stomach containing the ulcer is first mobilized, the gastrohepatic omentum is dissected free, the site of the ulcer encircled and marked by traction forceps and the crater accurately palpated. At the edge of the crater an incision is made. The crater of the ulcer in its situation on the posterior wall of the stomach is then visualized, excised with the cautery knife, the opening closed in an anteroposterior direction and the suture line covered by the peritoneal flap. The operation is completed by a gastroenterostomy. When ulcers of this size, between 1 and 2 cm., are near the pyloric end of the stomach and can easily be mobilized, partial gastrectomy is the operation of choice; but if they are distant from the pylorus our experience thus far has been that local excision by the cautery and a gastroenterostomy give such excellent results with such a small operative mortality that one hesitates to employ an operation of distinctly greater risk. Cautery excision combined with gastroenterostomy has been performed in the Clinic in 329 cases of gastric ulcer with an operative mortality of 2.12 per cent, a lower mortality-rate than has been associated with any other type of operation performed for gastric ulcer in the Clinic. In one series of 148 consecutive cases there was no operative mortality. Eighty per cent of the patients report satisfactory results from the

operation. Fourteen per cent are only slightly improved, 4 per cent failed to derive any relief and 1.1 per cent are known to have developed ulcers subsequently.

Ulcers over 2 cm. in diameter, as shown by MacCarty, should be regarded as malignant or potentially malignant. Partial gastrectomy is unquestionably justified in these cases, gastrointestinal continuity being reëstablished by whatever method best meets the individual case. These large ulcers may, however, be in such a difficult situation that resection is not warranted. For example, large ulcers high on the lesser curvature, while not suitable for resection, may be thoroughly cauterized with little risk. We have dealt with a number of such cases in this manner, with surprisingly good results, even when a gastroenterostomy has not been performed at the same time. In some, excision of the ulcer with the cautery (which may have been only partial) has been combined with jejunostomy, as suggested by Moynihan, and catheter-feeding continued until healing has taken place. I believe there is a larger field for this operation than we have realized, and that Moynihan has drawn our attention to a very useful method of dealing with these awkwardly situated ulcers.

In the series of 725 cases of peptic ulcer in which cautery excision was performed, there have been 1.1 per cent of recurrences of ulcers, including gastrojejunal. There is apparently no greater tendency for an ulcer to recur at the point of excision (providing, of course, that the ulcer has been satisfactorily excised) than at any other part of the stomach. The fact that in 725 cases we have seen no evidence of a tendency for an ulcer to develop at the point of excision would disprove any theory or fear that the cautery of itself may give rise to ulcer. Mann has demonstrated that after extensive excision of the gastric wall by the cautery, healing was so perfect that it was impossible to detect where the excision had been made, and we have observed in patients operated on for other conditions at various intervals after such excision that the same perfect healing has taken place. This small percentage of recurrences of

ulcer following local excision and gastroenterostomy is not of itself an argument for routine gastrectomy in gastric ulcer. Moreover, if recurrence of ulcer does take place, resection of the pyloric end of the stomach can be performed. The resection can then be regarded as the second stage of an operation which is often advantageously carried out in two stages, namely, partial gastrectomy.

In a previous paper I have shown that the relatively high subsequent death-rate in patients operated on for gastric ulcer, in comparison with the normal subsequent death-rate following operations for duodenal ulcer, was due to gastric cancer. Cancer may and does develop after any operation for gastric ulcer from a gastroenterostomy to partial gastrectomy, but almost all cancers develop in those cases in which the lesion was not removed, and, judging by the early death from cancer following operation, malignancy existed at the time of the operation. In 418 cautery excisions for gastric ulcer, 8 patients (1.9 per cent) have subsequently died of cancer of the stomach, but this group includes those cases of inaccessible ulcer in which it could not be completely excised and the earlier cases in which we were not familiar with the most effective manner of using the cautery. Furthermore, the incidence of cancer of the stomach in 418 persons of similar age (average forty-five years) in the general population is about 0.3 per cent. Our results indicate, therefore, that when a non-malignant gastric ulcer is satisfactorily excised and gastroenterostomy performed the incidence of gastric cancer following the operation is little more than it is in the general population.

The cautery is a useful adjunct in the management of ulcers on the posterior wall of the stomach, particularly when they are adherent to the pancreas. In these cases it is necessary, in order to secure good end-results, to separate the stomach from the pancreas; the edges of the opening are then excised with the cautery and the area on the pancreas thoroughly seared.

Duodenal Ulcer. In cases of duodenal ulcer we have not the same indications for excision, for while the excision of gas-

tric ulcers is imperative the excision of duodenal ulcers is not, because of the liability to cancer degeneration in the former and the absence of it in the latter. There are, however, two types of cases in which excision may be considered, small ulcers of the anterior wall with little scar formation, and ulcers which have been the cause of bleeding. The first group, that is, small duodenal ulcers of the anterior wall, may be safely removed by puncture with the cautery, the opening closed and a gastro-enterostomy performed. The mortality-rate following such operations will be under 1 per cent and the end-results will be excellent in 85 per cent of the cases. In the uncomplicated cases however, these results do not show any clear advantage over gastroenterostomy.

Bleeding Type of Ulcer. Experience has shown that an ulcer which has been the cause of bleeding may again bleed if it is not excised. I found that if the ulcer were not excised in cases in which there was a history of hemorrhage before operation, 13 per cent of the patients had hemorrhages after operation, even though all other symptoms have been completely relieved. Therefore, particular efforts were made to excise all ulcers in such cases, whether in the duodenum or stomach. As there are sufficient reasons for the routine excision of gastric ulcer other than a history of bleeding, this practice has not given rise to any new problems in the surgery of gastric ulcer, but it has in the surgery of duodenal ulcer.

The common location for duodenal ulcers, whether or not they have been complicated by hemorrhage, is on the anterior wall of the duodenum, and fortunately in this situation they can easily be excised either by cautery or knife. Multiple duodenal ulcers are found in 5.13 per cent of cases, and this fact should be kept in mind when dealing with the bleeding type of ulcer.

Careful exploration, first by palpation, followed by inspection of the anterior wall through the opening made by the excision of the ulcer, is imperative under such circumstances and will not infrequently reveal unsuspected lesions in some other portion of the duodenum, usually the posterior wall.

Resection of the duodenum may be necessary to remove satisfactorily one or more ulcers; the incidence of subsequent hemorrhage, when such bleeding ulcers, whether gastric or duodenal, are radically dealt with, has been reduced more than one-half. Hemorrhage may recur, however, even after careful exploration and radical excision of all lesions, and it is then probable, unless new ulceration has occurred, that the hemorrhages are dependent on causes extrinsic to the stomach operating through the liver.

The cautery is valuable in its applications to three groups of cases: (1) Small gastric ulcers in any situation, (2) ulcers of any size in a situation of difficult accessibility and (3) bleeding gastric or duodenal ulcers.

PANCREATIC ASTHENIA. A SYMPTOM-COMPLEX APPEARING AS A POSTOPERATIVE COMPLICATION IN PATIENTS WITH LESIONS OF THE PANCREAS

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CERTAIN symptoms have been recognized for many years, as occurring in pancreatic disease. These are asthenia, anorexia, nausea and vomiting, a tendency to hemorrhage, ptyalism, abnormal stools, epigastric pain and tenderness and rapid emaciation. One or more of these symptoms are mentioned by the numerous investigators in their discussions of the clinical picture of inflammatory and neoplastic lesions of the pancreas. Robson[1] emphasizes wasting and anorexia as present in the postoperative course of pancreatitis. Hotchkiss[2] reports a case of asthenia following operation for suppurative pancreatitis. But so far as the writer has been able to determine in a review of the literature a group of these symptoms has not been described as a syndrome appearing as a postoperative complication in the surgical therapy of the biliary tract and pancreas. In discussing the subject with several of the members of this Association, it is evident that this symptom-complex has been noted by many of them and is considered a puzzling and difficult problem in the postoperative therapy of their biliary cases.

I desire to present an analysis of 18 cases with this complication from the surgical service of the Presbyterian Hospital, New York City. Seventeen of these patients were under my care, the eighteenth was recently operated upon by Dr. F. B. St. John and is included in this series with his kind permission.

In a series of 230 consecutive unselected cases of diseases of the biliary tract and pancreas operated upon by the writer, special attention has been paid to the pathology, symptoms, complications and results as related to the pancreas. Of these 230 cases 40 showed definite pancreatic lesions. The cases with questionable or moderate thickening of the pancreatic tissue about the common duct are not included. (See Table I.) Eighteen of these cases presented the complication which because of its most striking and constant symptom, asthenia, has been named pancreatic asthenia. At the Presbyterian Hospital we regard it as an entity. It is characterized by extreme asthenia-anorexia—in some cases a very loathing for all food, apathy, nausea and vomiting, a marked drop in blood-pressure, rapid loss of weight. In some cases there has been noted in addition a tendency to hemorrhage, with and without jaundice or biliary fistula, ptyalism, pain and tenderness over the pancreas, obstipation and diarrhea. (See Table II.)

TABLE I.—PATHOLOGY OF THE 40 CASES WITH PANCREATIC LESIONS

Acute inflammatory lesions:		
Hemorrhagic pancreatitis	2	
Suppurative pancreatitis with fat necrosis	4	
Abscess of the pancreas	1	
	—	7
Chronic inflammatory lesions:		
Chronic pancreatitis without cholecystitis or cholelithiasis	4	
Chronic pancreatitis with cholecystitis and cholelithiasis	7	
Pancreatic lymphangitis involving the entire head with cholecystitis and cholelithiasis	6	
	—	17
Diabetes mellitus with cholecystitis and cholelithiasis		5
Carcinoma of the pancreas:		
Primary carcinoma of the pancreas	8	
Primary carcinoma of the gall-bladder with metastases to the pancreas	2	
Primary carcinoma of the stomach with metastasis to the pancreas	1	
	—	11

TABLE II.—ANALYSIS OF SYMPTOMS IN 18 CASES OF PANCREATIC ASTHENIA

Asthenia was present in 18 cases.
Anorexia was present in 18 cases.
Apathy was present in 15 cases.
Nausea and vomiting were present in 18 cases.
Loss of weight was present in 18 cases.
Marked and continued fall in blood-pressure was found in all of the last 7 cases on whom daily determinations were made.
Tendency to hemorrhage present in 6 cases.
Ptyalism present in 2 cases.
Pain and tenderness over the pancreas present in 3 cases.
Jaundice appeared after operation, present in 5 cases.
Obstipation was present in 2 cases.
Diarrhea was present in 2 cases.

Pancreatic asthenia has appeared in our cases at intervals after operation varying from the second to the ninth day, and has lasted for periods varying from two to thirty days, the average period being twelve days. The symptoms appear, as a rule, after the patient has recovered from the shock of the operation, when he is apparently doing well. In the patients recovering from this condition the change for the better is often surprisingly abrupt, appearing with a sudden return of appetite and relish for food. It differs from the cholemic state that one sees in cases with long-standing biliary obstruction and damaged liver. These patients with pancreatic asthenia are never comatose. They maintain a clear sensorium, are never delirious. Languor and apathy are pronounced. Weakness is their chief complaint. Asthenia, anorexia, nausea, drop in blood-pressure have been the first symptoms to appear. The asthenia is as marked in some cases as it is in Addison's disease. It is a subjective symptom causing the patient real concern. It is objectively manifested by the muscular relaxation, the mask-like facial expression, the feeble drawling voice, the weakened grip. All effort is avoided. Treatments are dreaded and exhausting. Oser, in his monograph on pancreatic disease,

described this asthenia, but not in the postoperative period. In discussing chronic indurative pancreatitis, he says:[3] "It is a well-known fact that many patients suffering from gall stone, even without permanent jaundice, become so very weak and rapidly emaciated that the development of cancer is suspected, and yet after a long time patients wholly recover." Again in discussing asthenia in carcinoma of the pancreas, he remarks: "One peculiarity especially is frequently pronounced and manifest in the cachexia caused by pancreatic cancer, namely, the great weakness and prostration which cannot be explained by the inanition alone. The sensation of weakness may be too great for words—the patient avoids expression of suffering because it is worse to bear than the violent pain. The patients lie quiet and apathetic."[4] Apathy and languor have been noted in all of our cases, and is considered a result of the asthenia.

Anorexia is a constant symptom. In several of our patients there has been an aversion for all food, even fluids. This has been noted as independent of the nausea. Oser,[5] in speaking of anorexia in pancreatic disease, mentions "a loathing for food, especially for meats." Nausea and vomiting may be very marked; it has been present in all of our cases and has complicated the maintaining of fluid intake.

Blood-pressure studies have been carried out in our last 7 cases. There has been a constant finding of marked drop in blood-pressure readings during the pancreatic asthenia as compared to the preoperative readings. In one patient, with a pressure of 215 130 before operation readings of 110/80 to 120/80 were noted during the course of her asthenia, which lasted three weeks. Subsequent to her leaving the hospital her pressure rose to 200 120. In another patient preoperative readings showed 110 70. During the most marked manifestations of his asthenia his systolic pressure fell to 50 with an imperceptible diastolic. No other observations on low blood-pressure in pancreatic disease after operation have been found in the literature.

TABLE III.—ANALYSIS OF PATHOLOGICAL FINDINGS IN 18 CASES OF PANCREATIC ASTHENIA

Case.	Operative findings and operation.	Result.	Autopsy findings.
1	Abscess in head of pancreas; drainage of abscess	Recovery 24 mos. 4 4 4	
2	Chronic pancreatitis involving the entire pancreas; gall-bladder full of calculi; cholecystectomy, choledochostomy	Died	Hemorrhage in the interlobular septa; ducts dilated; acute interstitial pancreatitis.
3	Fat necrosis in omentum; head of pancreas hard, nodular, edematous; gall stones in the gall-bladder and the common duct; cholecystectomy, choledochostomy	Recovery 20 mos. 4 4 4	
4	Chronic cholecystitis; no calculi were found in gall-bladder or ducts; lymph nodes were enlarged along cystic and common ducts; lymphangitis of the head of the pancreas; cholecystectomy, appendicectomy	. . .	She developed jaundice with asthenia and loss of weight; lived 26 mos.; died of chronic pancreatitis; autopsy not obtained.
5	Chronic cholecystitis, calculi in gall-bladder and common duct; entire pancreas was markedly enlarged, edematous, indurated; nodes were enlarged along the duct and over the head of the pancreas; cholecystectomy, choledochostomy	Died 20th day	Pancreas firm, nodular, enlarged, considerable increase in the interlobular connective tissue, especially in body and tail.
6	Chronic cholecystitis, calculi in gall-bladder, one in common duct; the entire pancreas was hard, nodular and enlarged throughout; cholecystectomy, choledochostomy	Recovery 17 mos. 2 4 4	
7	Hydrops of gall-bladder, no calculi; common duct dilated, no calculi; pancreas showed a large, hard, nodular head with a cyst in its upper aspect; cholecystduodenostomy	Died	Patient recovered after her pancreatic asthenia; tumor or mass which had been palpable before operation disappeared in epigastrium for several months; symptoms of asthenia recurred at end of 18 mos. and she died 1 mo. later; autopsy not obtained as she died in a small suburb.

Case.	Operative findings and operation.	Result.	Autopsy findings.
8	Acute and chronic cholecystitis; chronic cholangitis (B. coli communis); calculi in gall-bladder and common duct; enlarged nodes along common duct and over head of pancreas; lymphangitis of entire head of pancreas; cholecystectomy, choledochostomy	Recovery 42 mos. 4 4 4	
9	Walls of gall-bladder calcareous; gall stone 5 x 4 x 4 cm. occupied the shrunken gall-bladder and compressed the common duct; lymphangitis of the head of pancreas; she had been jaundiced eight months; liver markedly enlarged; cholecystostomy	Recovery 56 mos. 4 4 4	
10	Chronic cholecystitis; calculi in gall-bladder and common duct; lymphangitis of entire head of the pancreas; cholecystectomy, choledochostomy.	Recovery 12 mos. 4 4 4	
11	Chronic cholecystitis; chronic pancreatitis; entire head and tail hard, nodular and enlarged; cholecystectomy, choledochostomy	Recovered 21 mos. 4 4 4	
12	Chronic cholecystitis; single cholesterin stone in gall-bladder; 2 mos. pregnancy; cholecystectomy	Died 28th day	Developed pancreatic asthenia with jaundice on 2d day; this persisted until 26th day; she then had very severe epigastric pain; developed hemorrhage and went into collapse. Autopsy: Acute diffuse cholangitis, hematoma in submucosa of the duodenum, closing lumen of the bowel; hemorrhages into the retroperitoneal tissues; fat necrosis; sclerosis of pancreas with hemorrhage in it.
13	Gall-bladder distended, acutely inflamed; no calculi found in gall-bladder or ducts; head of pancreas very hard, nodular; common duct dilated. Diagnosis: Acute cholecystitis or carcinoma of pancreas; cholecystectomy, choledochostomy	Died 14th day	She showed hemorrhages into bowel and subcutaneous tissues.

Case.	Operative findings and operation.	Result.	Autopsy findings.
14	Carcinoma of gall-bladder; chronic cholecystitis; calculi in gall-bladder; chronic pancreatitis; cholecystectomy, transduodenal; choledochostomy	Died 19th day	Autopsy: Chronic pancreatitis, acute pancreatitis; necrosis and liquefaction of periduodenal tissue and duct of Wirsung; carcinoma of pancreas, liver, ovary and adrenal.
15	Carcinoma of body of pancreas; exploratory celiotomy	Died 15th day.	
16	Carcinoma of pancreas; cholecystgastrostomy	Died 2d day.	
17	Carcinoma of gall-bladder; carcinoma of common duct; calculi in gall-bladder; cholecystectomy, choledochostomy		She developed typical pancreatic asthenia on 2d day; these symptoms continued for 16 days, when she was taken to her home by her family; she died 2 mos. later; whether or not the pancreas was involved in this case not determined, as autopsy was not obtainable.
18	Carcinoma of pancreas; cholecystostomy	Died 20th day.	

A tendency to hemorrhage has been noted in 2 of our cases without jaundice, in 4 with jaundice. Prolonged bleeding and clotting time was a serious complication in these 6 cases. Jaundice appeared for a few days during the period of asthenia in 4 of our cases in whom stones were not found in gall-bladder or ducts at time of operation. In one of these patients jaundice continued for almost two years after the onset of the pancreatic complication. Ptyalism or excessive salivation was present in 2 of our cases during the pancreatic asthenia. This symptom is one of the earliest attributed to pancreatic disease. Schmackpfeffer,[6] in 1817, first called attention to it. Battersby,[7] in 1844, noted ptyalism in a case of pancreatic cyst, as did Ludolf,[8] in 1890. Halzmann,[9] in 1894, Caparelli,[10] in 1892, Guidiceandra,[11] in 1896, discussed this symptom in cases of pancreatic calculus. Friedrich,[12] in 1878, considered it a result of stomach involvement. Oser[13] explains it on the basis of associated nausea. A low sugar tolerance was determined in one of the 18 cases after the asthenia disappeared. Pancreatic

asthenia did not occur, however, in any of the 5 diabetics operated upon for gall-stone disease.

Course of the Complication. The symptoms showed a duration of two to thirty days, the average period being twelve days. Save in carcinoma cases the syndrome cleared abruptly with the return of appetite. In several of the cases this change was striking. The request for bizarre dishes is often the first indication of subjective improvement. Thus Case I, after three weeks of refusing all food, even the simplest fluids, one morning informed us she was hungry and desired a dish of tripe. When this was prepared by her daughter she ate it with gusto and proceeded to an uninterrupted recovery. Case VI, after eleven days of complete anorexia, asked for a piece of juicy steak. He recovered progressively thereafter. The rapid gain in weight and sense of well-being have in several of our cases been as striking as was the loss of weight, asthenia and apathy during the course of the complication.

Pathology. The pathological findings in these 18 cases, as determined at operation or postmortem, have been variable and in several of the cases very puzzling. Speculation as to the pathological findings in a given case of pancreatic disease is as hazardous today as in Fitz's time, who, after twenty-seven years of investigating in his masterly way the pathology of the pancreas, remarked,[14] in 1903, that: "Morbid changes in the pancreas are found frequently after death without symptoms having been observed during life to indicate their presence. On the other hand, the diagnosis of probable pancreatic disease, perhaps of the gravest sort, has been made from the recognition of one or more symptoms or signs which at times have been associated with alterations of the pancreas and the patient has recovered or the gland when exposed has presented no abnormal appearance." Yet it will be seen from the analysis of the pathological findings in Table III that definite pathology was found in the pancreas in all but Case XVII. Whether or not the carcinoma of the common duct in this case, found near the lower end of the duct, extended into the pancreas was not determined

at the operation. The patient died at home two months after leaving the hospital and autopsy was not obtained.

Treatment. This is largely directed to the relief of fluid depletion. Continual vomiting and disinclination to take fluids results in low urine output and nitrogen retention. Glucose infusions in 5 to 10 per cent solutions have been well taken without glycosuria. This would indicate that the islands of Langerhans are not involved in these pancreatic lesions. Blood transfusion has tided over several of our cases during the critical period of asthenia, especially those in whom it has persisted for more than ten days. Lavage of the stomach with hot saline solution or tap water has not controlled the vomiting as effectively as in other abdominal cases where ileus or gastric dilatation is a factor. For the tendency to hemorrhage we have found[15] intravenous infusions of calcium lactate in 0.2 to 0.5 per cent solution shortened the bleeding and clotting time and has controlled the hemorrhage in all but 3 cases, all of whom showed carcinoma of the pancreas.

Epigastric pain and tenderness is best relieved with poultices. Tympanites responds to hot colon irrigations in some, to medicated enemas in others. We have found digitalis, in the form of digitan, given by rectum in 10 cc doses, has improved the general vasomotor and intestinal tone in a number of our cases.

TABLE IV.—MORTALITY STATISTICS IN 18 CASES OF PANCREATIC ASTHENIA

Case 2.	Died 14th day.	Acute pancreatitis found at autopsy.
Case 5.	Died 20th day.	Chronic pancreatitis found at autopsy.
Case 12.	Died 28th day.	Acute pancreatitis found at autopsy; acute ileus.
Case 13.	Died 14th day.	Carcinoma of pancreas found at operation; hemorrhages into bowel and subcutaneous tissue.
Case 14.	Died 19th day.	Carcinoma of gall-bladder found at autopsy; chronic pancreatitis.
Case 15.	Died 15th day.	Carcinoma of body of pancreas found at operation.
Case 16.	Died 2d day.	Carcinoma of pancreas found at operation.
Case 18.	Died 20th day.	Carcinoma of pancreas found at operation.

Results. It will be seen from Table IV that of 18 patients showing this syndrome 8 died while in the hospital, 5 showing

carcinoma; 3 died after leaving the hospital in from two to twenty-six months. All of the surviving 7 patients show a symptomatic 4, relief from all symptoms, from twelve to fifty-six months after operation. From Table V it is evident that the lesions of the pancreas increase to a marked degree the hazard of the surgery of the biliary tract. In the entire series

TABLE V.—POSTOPERATIVE RESULTS IN THE 10 CASES LEAVING THE HOSPITAL

Case 1. 24 mos. 4 4 4
Case 3. 19 mos. 4 4 4
Case 4. Died at end of 26 mos. of a chronic pancreatitis.
Case 6. 14 mos. 2 4 4; has weakness in the scar.
Case 7. 18 mos. after operation tender mass reappeared in the epigastrium with jaundice and asthenia; died one month later.
Case 8. 42 mos. 4 4 4
Case 9. 56 mos. 4 4 4
Case 10. 12 mos. 4 4 4
Case 11. 24 mos. 4 4 4
Case 17. Died 2 mos. after leaving the hospital of carcinoma.

TABLE VI.—DEATH ANALYSIS IN 25 POSTOPERATIVE DEATHS IN A SERIES OF 230 PATIENTS OPERATED UPON FOR DISEASE OF THE BILIARY TRACT AND PANCREAS

15 of these cases showed pancreatic involvement.
11 showed carcinoma of the pancreas.
2 showed acute pancreatitis.
2 showed chronic pancreatitis.
Of the remaining 10 cases,
1 showed carcinoma of the cystic duct.
1 died of sepsis with B. coli chronic cholangitis.
3 died of cholemia with long-standing biliary cirrhosis and common duct-stone obstruction.
1 died of uremia following secondary cholecystectomy for common duct stone.
1 died of Welch bacillus cholecystitis and cellulitis.
1 died of vibrion septique cholangitis and cellulitis.
1 died of B. coli bacteremia and acute endocarditis.
1 died of multiple liver abscess.
In 172 cholecystectomies for inflammatory disease or calculus limited to the gall-bladder there was but one death, the result of an acute pancreatitis developing after operation.

of 230 cases analyzed there were 25 deaths in the hospital; of these 25 fatal cases 15, or 60 per cent, showed pancreatic involvement. (See Table V.) Of 172 cholecystectomies, however, with the pathology limited to the gall-bladder at time of operation, there was but one death—Case XII reported in the series with pancreatic asthenia—the result of an acute pancreatitis developing after operation.

Conclusions. 1. There is a group of symptoms appearing as a postoperative complication in patients with pancreatic lesions, characterized by asthenia, anorexia, nausea and vomiting, low blood-pressure and rapid loss of weight.

2. In a series of 18 cases reported, definite pathology of the pancreas was determined in 17 either at operation or postmortem.

3. The asthenia, anorexia, low blood-pressure and loss of weight are not dependent upon malignancy, inasmuch as 12 of the 18 cases reported showed pancreatitis rather than carcinoma.

4. The involvement of the pancreas increases to a marked degree the hazard of biliary surgery.

5. The inflammatory lesions and calculus formation limited to the gall-bladder should be treated surgically before the process of inflammation extends to the pancreas.

Case I.—J. K.; History No. 49474; age, fifty-one years; married.

Chronic cholecystitis; calculi in gall-bladder; chronic pancreatitis; abscess of pancreas (Staphylococcus aureus); acute pancreatitis; hypertension; asthma; pancreatic asthenia.

Chief Complaint. Pain in epigastrium in attacks, twelve years.

Twelve years ago began having attacks characterized by pain, severe, knife-like in epigastrium, radiating to back and both shoulders; right greater than left; relieved by vomiting.

Nausea and vomiting; never blood or coffee grounds.

Tenderness remained in right upper quadrant and epigastrium.

These attacks for three years came on every six to seven weeks, often induced by exertion, especially raising something above her head, as in hanging curtains. Usually had chilly feelings preceding attack of pain. Never jaundiced.

She was then free from attacks for several years. During the

past year she was troubled with indigestion, epigastric distress, anorexia, heavy feeling in upper abdomen.

Three days before admission, while motoring, was seized with a very severe attack similar to the ones she had nine to twelve years ago. Vomiting very severe, and on day of admission she brought up small, irregular stones, gravel-like. Doctor said she was jaundiced.

Past History. Never had typhoid. For twenty-three years has had severe asthma that now is very chronic and does not respond to usual climatic changes.

Three to four years ago had very severe "neuritis" in right side; excruciating pain with swellings over various parts of her body; in bed three months. For four years has had a high blood-pressure.

Ten years ago a pelvic operation.

Bowels always constipated.

Has had two children.

Px. Very highstrung, nervous, but very sane person. No jaundice. Asthmatic.

Chest: Emphysematous, typical of asthma.

Abdomen: Rounded; definite constant tenderness in right upper quadrant in midclavicular line. Sense of a mass in right upper quadrant. Liver edge 2 cm. below costal margin.

Blood-pressure, 200/100. Blood urea, 0.27 gm. per liter.

Wassermann negative. Group 1.

Urine shows no bile.

Skin reactions show no specific reactions.

March 26, 1921. Operation: Cholecystectomy (novocaine), one hour and twenty minutes; choledochostomy (chloroform).

Anteoperative diagnosis: Chronic cholecystitis; calculus in gall-bladder.

Postoperative diagnosis: Same, plus pancreatic lymphangitis.

Gall-bladder was markedly inflamed, thickened, contained many facetted calculi. None felt in common duct. Head of pancreas was hard, and because of this the common duct was drained. Cholecystectomy was completed under novocaine, choledochostomy under chloroform.

Incision: Vertical right rectus; drain; goiter tube in common duct; rubber tube in Morrison's pouch.

Pathological Report, No. 25945. Chronic cholecystitis; cholelithiasis.

Cultures: Staphylococcus aureus.

Complications: Abscess of pancreas, pancreatic asthenia, asthma.

She stood operation well and did well except for periods of vomiting. On sixtieth day following persistent biliary fistula, which had

closed, and several days of severe epigastric pain and tenderness over pancreas and left costovertebral angle, she developed an acute pancreatitis. On the sixty-fifth day she developed an ileus—high—and second operation showed a collection of pus in head of pancreas pressing on and shutting off, very largely, the duodenum. Common duct was not involved; not dilated. Abscess was incised as an emergency, with Dr. Bennett giving chloroform, and pus showing a Staphylococcus aureus evacuated. Drained. Following this she had a period of recurring asthenia; anorexia.

Blood-pressure fell to 120/80, and she vomited constantly. Finally, one morning, after three weeks of inability to take any nourishment postoperative she informed me that she wanted a dish of stewed tripe. Everything else had been tried to tempt her appetite without success. This was prepared for her by her daughter; she ate it with relish, and from then on her appeteite, asthenia and vomiting progressively improved. Drainage was maintained several weeks, and she left on the one hundred and third day with small sinus, gaining in weight and free from digestive disturbance. Weight, 120 pounds.

She was seen several times and each follow-up visit showed her to be in fine condition as far as her digestion went. Blood-pressure and asthma continued, however, and on February 2, 1923, twenty-four months after her gall-bladder operation, she was readmitted because of suppurative sinusitis. Weight, 170 pounds.

Blood-pressure, 185/90 to 190/125 to 180/100, etc.

Dr. Pratt opened up and drained left antrum and irrigated the frontals.

Kidney function: Phthalein, 35 per cent.

Twenty-four months: Abdominal scar firm; no tenderness; no hernia; 4 4 4.

Case II.—D. N., History No. 53137; widow; children, 5; miscarriages, 0; thin.

Chronic cholecystitis; calculus in gall-bladder (pure cholesterin) and common duct; acute pancreatitis; chronic pancreatitis; pancreatic asthenia with ptyalism and hemorrhage.

Chief Complaint. Pain in epigastrium, five months. Attacks: Sudden onset five months ago with nausea and vomiting and pain, gradually increasing dull to severe, epigastric, radiating to left hypochondrium, not definitely related to meals.

Vomiting; never blood or coffee ground.

These attacks, once or twice a month at first, are now two to three times a week. No jaundice; loss of weight, 25 to 30 pounds.

Past History. Typhoid thirty years ago. Tonsillitis and inflammatory rheumatism. Menopause five years ago; five pregnancies; no miscarriages.

Px. Emaciated, elderly, chronically ill woman weak and sick. Slight icteric tinge.

Weight, 110 pounds. Acetone odor to breath.

Heart: Frequent extrasystoles.

Blood-pressure, 120/70.

Abdomen: Enlarged liver; mass below this slightly tender; possible carcinoma of gall-bladder or hepatic flexure plus cholelithiasis; tenderness across epigastrium.

Urine: Very faint trace of bile; glucose, negative; albumin, very faint trace.

Wassermann negative; blood group, II.

Red-blood cells, 6,700,000; hemoglobin, 90 per cent; white-blood cells, 21,900; polymorphonuclears, 90 per cent; blood urea, 0.25 gm. per liter; CO_2, 55 volumes per cent; chlorides, 4.61 gm. per liter.

X-ray: No obstruction in colon.

Gastric analysis: Low HCl.

Operation, March 4, 1922. Cholecystectomy, choledochostomy (novocaine), one hour twenty-six minutes.

Anteoperative diagnosis: Chronic cholecystitis and calculus in gall-bladder; cancer of gall-bladder.

Postoperative diagnosis: Chronic cholecystitis, cholelithiasis, chronic pancreatitis.

Because of the build and coöperation of the patient, it was decided to try local anesthesia. This was carried out remarkably smoothly and successfully. On opening the peritoneum the mass felt at various times was very large gall-bladder, tense and distended, containing calculi. Common duct was dilated. This was considered the result of a hard, indurated pancreas rather than calculi, which were not found on exploration. Exploring forceps could be passed into duodenum, through the resistance of pancreas. Right rectus incision. Goiter tube in common duct, two cigarette drains in Morrison's pouch.

Pathological Report, No. 27181. Chronic cholecystitis, calculus (cholesterin).

Culture: Gall-bladder wall, Bacillus coli. Bile from gall-bladder: Bacillus welchii, Bacillus coli: Bile from common duct: Bacillus welchii, Bacillus coli.

Postoperative course: Clysis of 1500 saline. Comfortable day. Very little pain. No nausea or vomiting.

First day: Temperature, 101°; pulse, 100; blood-pressure, 115/70.

Comfortable night and day. No nausea, vomiting or distention. Taking water, Vichy and albumen water. Blood-pressure, 100/70. Bile drainage, 750 cc since operation.

Second day: Temperature, 98.8°; pulse, 80; blood-pressure, 120/80. No complaints; no distention. In late afternoon was given orange juice. This immediately gave her distress. Nauseated but could not vomit. Developed some gastric dilatation but relieved by lavage.

Third day: Good night; temperature, normal; blood-pressure, 110/80. In afternoon she began to complain of weakness, nausea, anorexia and showed marked ptyalism.

Fourth day: Condition same. Definite picture of pancreatic asthenia. Blood-pressure, 100/80.

Fifth day: Transfusion, 500 cc citrated blood; no reaction; temperature, 98°; pulse, 90; blood-pressure, 115/75. "Feels weak."

Sixth day: Poor night. Vomiting; very weak and apathetic.

Seventh day: Transfusion, 750 cc citrated blood; no reaction; temperature, normal; blood-pressure, 110/80; blood urea, 3.1 gm. per liter; chlorides, 4.18 gm. per liter; CO_2, 44 volumes per cent. Bowels very costive; no real movements since operation. Dressings soaked with very foul-smelling discharge. "Very languid."

Tenth day: Transfusion; blood-pressure, 130/80; posttransfusion. Thought to have duodenal fistula. Cultures of exudate same as operative cultures.

Eleventh day. Suction drainage. Blood-pressure, 115/80. Very nervous. Involuntary. No vomiting.

Twelfth day: Continuous infusion, 3500 cc 5 per cent glucose. Marked improvement in pulse and blood-pressure. Blood-pressure, 100/75. Great pain in epigastrium.

Thirteenth day: Fluid from wound shows amylase and protease. Red blood cells, 6,300,000; hemoglobin, 105; white blood cells, 29,600; polymorphonuclears, 90 per cent. Nausea and vomiting. Blood-pressure, 75/65. Involuntary. Developed left costovertebral angle tenderness and tenderness over tail of pancreas.

Fourteenth day: Died.

Autopsy, No. 9226. Anatomical diagnosis: Cholelithiasis; calculus in common duct; acute interstitial pancreatitis; acute local peritonitis; fat necrosis. Subcutaneous hemorrhages.

Body showed numerous subcutaneous hemorrhages. Pressure over duodenum caused fluid to well up through the common duct opening. No duodenal fistula as such was found.

Pancreas: Normal in size and consistency. An occasional area of fat necrosis is found in the fat. No hemorrhages or increase in connective tissue made out. Pancreatic duct not dilated.

Liver: Main bile duct is somewhat distended; hepatic duct large. In common duct close to the cystic duct there is a rectangular stone 0.5 cm. in diameter. Opening in ampulla wide.

Intestine: A traingle shaped stone with rounded corners found in transverse colon.

Adrenals: Normal in size.

Microscopic. Pancreas: Head: Striking feature is the dilatation of interlobular ducts and acini. These ducts are full of homogeneous pink-staining material. There is an interacinar infiltration with mononuclear cells and a few polymorphonuclears. There is some hemorrhage in the interlobular trabeculæ. Body and tail practically the same. Fat shows picture of necrosis.

NOTE.—The interesting feature in this case is the lesion in the pancreas. Clinically certain symptoms were noted and referred by the surgeons to pancreatic involvement. Pathologically there was found a low-grade infection, what may be termed an acute interstitial pancreatitis with striking dilatation of the acini. There is no reason to believe the obstruction of the main pancreatic duct is the cause. The absence of jaundice makes this improbable.

CASE III.—J. C.; History No. 51495; age, twenty-nine years; married; children, 0; mulatto; obese.

Chronic pancreatitis; chronic cholecystitis; calculi in gall-bladder and common duct; pancreatic asthenia with ptyalism; duodenal dilatation; duodenal obstruction.

Chief Complaint. Pain in epigastrium, three days.

Past History. Operation two years ago at Woman's Hospital for papillary cystadenoma of ovary; hysterectomy and salpingo-oöphorectomy. For several years has had gaseous eructations. Never any pain in abdomen radiating to scapula or back. Never jaundiced. Has had pains over abdomen for two to three years but indefinite.

Present History. Three days ago began to have indefinite colicky pains throughout abdomen. Next morning pains were worse. She vomited light yellow fluid, but was up all day with pain off and on. Next day took magnesium sulphate, with good result. Pains continued in paroxysms. Day before admission she stayed in bed, vomiting everything taken. Cramps became worse in epigastrium. Came to hospital because of increasing pain.

Px. She evidently was sick. Temperature, 102°; pulse, 88; respirations, 28; white blood cells, 18,000; polymorphonuclears, 84 per cent. Groaning in pain. Negative, save for abdomen.

Abdomen: Not distended; healed scar (suprapubic); tender everywhere; most tender over a fulness in epigastrium; tender in costovertebral angles. No visible peristalsis.

Vaginal: Fornices and cul-de-sac clear. Cervix scarred and retracted. No tenderness nor masses.

Patient showed *marked ptyalism.*

September 27. Temperature, 100°; pulse, 96; white blood cells, 21,000; polymorphonuclears, 92 per cent. Abdomen this morning a bit more distended. Tenderness localized to epigastrium.

September 28. Cramps continue, in paroxysms, making her writhe. Temperature, 101°; pulse, 90; white blood cells, 22,200; polymorphonuclears, 88 per cent. Retching, trying to vomit. Ptyalism continues. Poor result from colon irrigation and catharsis.

Duodenal contents show pancreatic ferments.

Diagnosis is between an intestinal obstruction and pancreatitis and acute gall-bladder.

X-rays showed definite duodenal obstruction.

Operation, October 7, 1921. Cholecystectomy, choledochostomy. Division of bands binding down duodenum.

Anteoperative diagnosis: Duodenal obstruction.

Postoperative diagnosis: Same, plus pancreatitis and cholelithiasis.

There were small punctate spots of fat necrosis in the omentum. These increased in number near foramen of Winslow. Over the peritoneum coving the right kidney and just above it there passed several strong bands of adhesions across the duodenum to head of pancreas, undoubtedly causing a certain amount of constriction. Head of pancreas was quite hard, thickened as if studded with hard lumps. The gall-bladder was tense, containing numerous gallstones. Common duct was dilated and contained calculi. *No remains of carcinoma found in abdomen.*

Incision: Midline epigastric. Drain: Common duct and rubber tube to Morrison's pouch.

Pathological Report, No. 26677. Chronic cholecystitis; cholelithiasis. Cultures: no growth.

Postoperative course: Second day: Vomiting. Pain in back severe. Draining bile freely. Very *apathetic.*

Third and fourth day: Pain continues. Ptyalism continues.

Fifth day: Clay-colored stools.

Sixth day: Vomiting again. Pain in back severe. Sugar tolerance low.

Seventh day: Vomiting again. Pain in back and epigastrium severe.

Ninth day: Vomiting again. Pain in back severe.

Eleventh day: Appetite returning. Feels much better.

Thirteenth day: Stool clay-colored.

Eighteen day: Stool brown. Bile fistula closed.

Home on thirty-second day. Weight, 147 pounds.

Two months: 4 4 4. Eats everything. Feels perfectly well. No constipation. Weight, 157 pounds. Liver cannot be felt. Urinalysis negative.

Seven months: 4 4 4. Weight, 166 pounds. No complaints except obesity.

Twelve months: 4 4 4. Weight, 167 pounds.

Sixteen months: 4 4 4. Weight, 158 pounds.

Eighteen months: 4 4 4. Weight, 162 pounds. Blood sugar, 1.02 gm. per liter.

Twenty months: 4 4 4. Weight, 156 pounds. No indigestion. No pain. Blood sugar now normal. No recurrences of salivation.

Case IV.—A. C.; History No. 48697; age, fifty-four years; widow; children, 3.

Chronic cholecystitis; chronic pancreatitis; perihepatitis; pancreatic asthenia.

Chief Complaint. Attacks of abdominal pain: September, 1919; May, 1920; August, 1920; December, 1920. Now has daily attacks.

Pain: Colicky, changing to gnawing, dull ache, localized to right upper quadrant, not related to nor relieved by food.

Tenderness in right upper quadrant spreading across to left upper quadrant.

No nausea or vomiting.

Bowels constipated for seven years; rarely formed because of catharsis; never black; at times light.

Jaundice (?) as a child.

Digestion: No bloating, belching nor sense of distress or distention in epigastrium.

Urinary: Negative.

Three pregnancies; never associated with abdominal colic. Menopause in 1920.

Five nervous breakdowns.

No typhoid.

Three railroad accidents.

Perineorrhaphy and Alexander operation.

Has had much trouble with her teeth. Many apical abscesses. Many extractions.

Px. Patient looks older than her years. Somewhat petulant, poorly nourished. Much gum recession in remaining teeth.

Temperature, 98.4°; pulse, 100; respirations, 20; blood-pressure, 130/70; weight, 110 pounds.

Abdomen: Ptotic in type. Tenderness across pancreas and in left costovertebral angle.

Pelvic: Negative.

Wassermann negative. Phthalein, 48 per cent; urea, 0.48 gm. per L.

January 22, 1921. Cholecystectomy, appendicectomy (gas and oxygen, novocaine).

Anteoperative diagnosis: Chronic cholecystitis.

Postoperative diagnosis: Same.

Omentum was adherent to fundus of gall-bladder. Walls of gall-bladder were somewhat thickened. It emptied with difficulty but contained no stones. Nodes along cystic duct and gastrohepatic omentum were enlarged. Head of pancreas thickened along duct. There was a marked perihepatitis of right lobe of liver to right of gall-bladder, manifesting itself as a whitish, thickened, peritoneal coat. Common duct felt normal. Rest of exploratory negative. Hockey-stick incision. Rubber tube to Morrison's pouch.

Pathological Report, No. 25658. Chronic cholecystitis. Cultures: No growth.

Complications: Jaundice, asthenia.

Postoperative course: First day: Complained of weakness, pain in epigastrium.

Third day: Jaundiced; very tired.

Fourth day: Very apathetic; more jaundiced.

Seventh day: Bowels very constipated; pulse weak; asthenia.

Eighth day: Complete anorexia; pulse weak; asthenia.

Ninth day: Appetite better. Bowels moved a little; grayish-brown stool. Color clearing. Irrational.

Fourteenth day: Steadily improving; jaundice cleared.

Nineteenth day: Remaining teeth extracted.

Twenty-ninth day: Home.

Patient did very well for five or six weeks after leaving the hospital. Jaundice cleared. She then went to her summer residence in Highland Falls and while being helped out of a rowboat by someone lifting her by her abducted arm, she felt a sudden, tearing, severe pain in right upper quadrant and right costal margin. Following this she developed jaundice in rather intense form, pruritus became very severe and distressing and from then on she remained jaundiced with some remissions in intensity. For weeks at a time was unable to do much more than get about, but could not work. I saw her in the summer of 1921 and again in December, 1921. She was jaundiced; weighed from 85 to 95 pounds; was asthenic; showed a marked enlargement of her liver 8 to 10 cm. below costal margin, with a hard liver edge and surface of liver. She improved for a time and I saw her in May, 1922, when she went out West to stay with friends.

Diagnosis of chronic pancreatitis seemed the logical one. Neoplasm or carcinoma of pancreas was ruled out by history, operative findings and her subsequent survival of two years.

In March, 1923, she had a severe gastric hemorrhage, dying as the result of it. She was in the country at the time and no autopsy was obtainable.

Twenty-six months: Result, death.

Case V.—A. W.: History No. 47203; age, forty-one years; widow; housework; children, 2; miscarriages, 2. Jaundiced.

Chronic cholecystitis; calculi in gall-bladder; calculi in common duct; subacute pancreatitis; pancreatic asthenia; diverticulum of common duct.

Chief Complaint. Pain in epigastrium, eight months.

Past History. Since February, 1920, has had four to five attacks.

Pain: Acute in epigastrium, radiating to right shoulder. No nausea or vomiting.

Four days ago had a severe attack with pain in right upper quadrant and epigastrium, radiating to interscapular region with nausea and vomiting.

Jaundice has appeared within two days.

Tenderness in right upper quadrant, six days.

Interval digestive disturbances for eight months.

Hemithyroidectomy eight years ago.

Px. Patient looks sick. Skin and scleræ jaundiced.

Abdomen: Distended; tender in right upper quadrant; epigastrium and right scapula.

Gall-bladder palpable, tender; liver edge palpable 3 cm. below costal margin.

Duodenal bucket: Non-hemolytic streptococcus in all anteoperative and postoperative specimens. Gall-bladder tissue same.

Blood coagulation, thirteen and a half and fifteen minutes.

Wassermann negative.

Feces negative for bile.

August 30, 1920. Cholecystectomy, choledochostomy (gas and ether, one hour and thirty-five minutes).

Anteoperative diagnosis: Cholelithiasis, calculi in gall-bladder and common duct.

Postoperative diagnosis: Same, plus pancreatitis.

Gall-bladder showed definite numerous adhesions to duodenum and was filled with stones and inspissated bile. Cystic duct was patent; common duct was dilated, contained ten to twelve stones, facetted. Pancreas was very much swollen, edematous, indurated

and the seat of severe lymphangitis. Nodes were enlarged along head of pancreas and gastrohepatic omentum. Common duct bile was turbid.

Incision: Right rectus. Drain: Fishtail to common duct; rubber tube to Morrison's pouch.

Pathological Report, No. 25050. Cholelithiasis, chronic cholecystitis, chronic pancreatitis.

Postoperative course: Fifth day: Began complaining of severe pain in epigastrium, nausea and vomiting.

Sixth day: Complained of severe pain in epigastrium, nausea and vomiting.

Ninth day: Complained of weakness; apathetic.

Tenth day: Complained of weakness. Vomiting; clay-colored stools.

Eleventh day: Apathetic.

Fourteenth day: Nausea, discomfort in epigastrium; very weak and apathetic.

Seventeenth day: Nausea and vomiting; very weak and apathetic; stools yellow.

Eighteenth day: Vomiting everything; very apathetic; pulse at times so weak it cannot be felt; patient's voice very weak; mind clear; no temperature.

Nineteenth day: Very apathetic; losing ground.

Twentieth day: Pulse weaker and thready. Died at 4 P.M.

Autopsy No. 9060. Cholelithiasis; stone in common duct and ampulla; chronic pancreatitis; fat necrosis about hilus of spleen.

Abdominal cavity: Subperitoneal tissues about operative wound are black. Abdominal cavity is dry; no evidence of peritonitis. One small spot of fat necrosis on anterior surface of body of pancreas and a few spots near hilus of spleen. Through the operative wound a probe can be passed through a tract leading toward the head of the pancreas to a region where a lymph node 2 cm. in diameter shows dilated lymphatics. On separating the adhesions the tract is found to lead to an operative opening in the common duct. A small cavity is found near the beginning of the common duct which contains purulent yellow material. On opening duodenum, papilla of Vater stands out prominently. The orifice is easily entered with a probe, which pushes out a facetted gallstone 7 mm. in diameter. On opening the common duct it is found to be dilated to a diameter of 7 mm. The main pancreatic duct joins the common duct 1 cm. above the duodenal opening of papilla. The ampulla of Vater is found to have a diverticulum or pouch in which fits snugly another facetted yellow, soapy gallstone. The pancreatic duct is enlarged behind the

stone, but on dissecting up the duct to the tail no general dilatation or other abnormality is found.

Pancreas: Color, pinkish-yellow; consistency quite firm and nodular; possibly increased in size, especially in the body; not markedly congested or edematous.

Liver: From the cut bile ducts yellow granular bile exudes. At the hilus of the liver are several enlarged lymph nodes 2 cm. in diameter.

Adrenals: Relatively large. Cortex contains abundant lipoid material; normal medulla.

Microscopic. Pancreas: Head: The acini are practically normal. There is no interstitial edema. Islands normal. Ducts are mostly collapsed. There is autolysis of the pancreas near the periphery. Body: There is considerable increase in interlobular connective tissue, frequently in broad bands. No edema. Tail: Less fibrosis than in body. In one fibrous area there is a hemorrhage.

Liver: The liver is negative except for phagocytes in the sinusoids near the efferent vein, containing bile pigment. The connective tissue in the portal areas is somewhat denser than normal, but the changes are very slight.

Case VI.—F. H.; History No. 52340; age, forty-six years; married; butcher. Jaundiced; average build.

Chronic cholecystitis; chronic pancreatitis; calculus in gall-bladder; calculus in common duct; pancreatic asthenia.

Chief Complaint. Jaundice. Attacks of right upper quadrant pain.

Past History. Appendicectomy at Presbyterian Hospital in 1913.

Present History. In August, 1920:

First attack: Pain in right upper quadrant, radiating into back. Vomited. Attack lasted twelve hours. Well in three to four days.

Second attack: Ten days later similar attack with jaundice. In September, began to have interval digestive disturbances, bloating and belching. This has continued.

Third Attack: October 11, 1921: Severe pain; no jaundice. October 21: *X*-rays showed large collection of gallstones.

Fourth attack: December 18: Pain, fever, jaundice, clay-colored stools. Jaundice deepening. Admitted to hospital.

Px. Well developed and well nourished. Sick; jaundiced skin and scleræ.

Abdomen: Tenderness and spasm in right upper quadrant. Smooth liver; edge felt 3 cm. below costal margin. Dulness to third rib. No tenderness over pancreas.

Blood coagulation, nine and a half minutes. Cholesterol, 0.208 per cent.

1000 cc of calcium lactate, 0.2 per cent given.

Weight, 165 pounds. Blood-pressure, 145/100.

December 24, 1921. Cholecystectomy, choledochostomy (gas and ether, one hour and five minutes).

On opening the peritoneum the main lesion was found to be in the pancreas, which was very hard, indurated and enlarged throughout its extent. No soft areas nor fat necroses were seen. Common duct was dilated. On opening it flocculent turbid bile came away copiously. One gallstone was found in the duct. Gall-bladder was thickened and contained gallstones.

Incision: Right rectus. Drain: Rubber tube in common duct; rubber tissue to Morrison's pouch.

Pathological Report, No. 26953. Chronic cholecystitis; cholelithiasis.

Culture of gall-bladder: Streptococcus fecalis.

Complications: Group IV lobar pneumonia; pancreatic asthenia.

Second day: Cough; dyspnea; left lower lobe consolidation; white blood cells, 21,000; polymorphonuclears, 90 per cent.

Fifth day: Jaundice cleared; lungs clear.

Sixth day: Large yellow stool.

Ninth day: Began to ooze and jaundice recurred somewhat; clotting time, fifteen minutes; control, fourteen minutes; appetite gone.

Tenth day: Very asthenic; no appetite; tired all the time; muscle in region of wound melting away.

Fourteenth day: Blood-pressure, 80/50.

Fifteenth day: Blood-pressure, 80/50; no appetite; listless; blood clot in wound; culture, Streptococcus fecalis; tube came out of common duct.

Seventeenth day: Blood-pressure, 95/65; temperature, pulse and respirations practically normal.

Nineteenth day: Blood-pressure, 80/45; profuse biliary discharge; no evidence of repair; Loewi adrenalin test negative; pancreatic ferments present in duodenal contents and all normal except for starch.

Twentieth day: Blood-pressure, 80/45; appetite suddenly returned and patient asked for piece of juicy steak, and got it.

Twenty-second day: Blood-pressure, 80/45.

Twenty-third day: Blood-pressure, 90/45.

Twenty-fifth day: Blood-pressure, 90/40.

Twenty-seventh day: Blood-pressure, 100/50.

Twenty-eighth day: Blood-pressure, 100/50.

Thirtieth day: Blood-pressure, 115/55.

Fortieth day: Sugar-tolerance test: Fasting blood sugar, 1.04 gm.

per liter; two hours' blood sugar, 1.43 gm. per liter. Urine before test, ±; two hours, ±; four hours, 1+; six hours, 1+; shows some decrease in sugar tolerance.

Weight on leaving, forty-first day postoperative, 151 pounds. Forty-seventh day postoperative, wound healed.

Three months: 4 4 4. No symptoms. Digestion good. Bowels regular without catharsis. Patient is following diet given. Weight, 163 pounds. No recurrence of jaundice.

Ten months: 2 4 4. Weight, 191 pounds. Absolutely no digestive disturbances. Wound shows a well-defined bulge. Advised to wear a belt.

Fourteen months: 2 4 4. Has no symptoms whatsoever. Is working at his trade as butcher. Weight, 190 pounds. Wears belt.

Case VII.—C. L.; History No. 37063; age, sixty-five years; single; housework. Jaundiced; thin.

Chronic pancreatitis; cyst of pancreas.

Chief Complaint. Jaundice for three weeks.

Past History. Jaundice at seven years. No typhoid; no tonsillitis. At twenty-five years had diarrhea and vomiting for ten days. Chronic arthritis for several years. Hemorrhoids ten years. Always very constipated. Habitual catharsis taker. Stools never tarry. Never had indigestion until present illness. Past history otherwise negative.

Present Illness. Began with an attack of "autointoxication" four weeks ago. She felt weak; belched much gas; bowels very costive. No headache, pain or vomiting.

One week later, three weeks ago, a friend told her she was yellow. That night she had very severe bloating and belching. This has continued since. Stools now became clay-colored, and have remained so. Urine dark, jaundice deepening. Occasional vomitus has been white mucus; no blood. Has lost some weight. Has had no pain.

Px. Well-developed, thin woman, aged sixty-five years. Deeply jaundiced skin and scleræ.

Abdomen: Normal contour; no tenderness; no rigidity; no shifting dulness. Liver edge not felt, but a mass the size of a lemon can be felt projecting below the costal margin, sharply outlined, freely movable, hard, not tender.

Wassermann negative. Free HCl, 6; total, 36. Blood, 0.

X-ray showed enlarged gall-bladder. Stomach: No ulcer or carcinoma.

Red blood cells, 4,600,000; hemoglobin, 85 per cent; white blood cells, 8000; polymorphonuclears, 70 per cent.

Blood-pressure, 150/70. Blood-clotting time, eighteen minutes. Weight, 114 pounds.

Operation, January 26, 1918: Cholecystoduodenostomy. Incision: Transverse (one hour and thirty-nine minutes). Gall-bladder was found greatly distended, not collapsible. No stones were felt in it or ducts after aspiration. The walls were not chronically inflamed. It contained a very thick green bile with mucus. Cystic duct was patent. Common duct was dilated 1.5 cm. Pancreas was definitely the seat of disease, in the head, especially around the duct. This part was very hard, nodular and extended up above and behind the pylorus. Here there was a cyst 3 cm. in diameter. Liver was not enlarged and no masses were felt on its surfaces. Enlarged nodes felt in gastrohepatic omentum, adherent to duct and portal vein. Culture from bile, no growth.

No complications. Healing by primary union; no fistula; some asthenia.

Three months: 2 4 4. Weight, 118 pounds. Mass palpable in epigastrium.

Five months: 3 3 2. Had chills called "malaria." Mass vaguely made out in epigastrium.

Ten months: 4 2 2. Weight, 99 pounds. Appetite not good. Slightly jaundiced. Mass had disappeared. Markedly asthenic.

December 5, 1918. Twelve months: Readmission note: For four to five months postoperative mass in epigastrium corresponding to the enlarged pancreas, increased in size and after that steadily decreased in size until now none can be made out. Until two months ago her general condition improved, since then she has lost weight and strength and has had intermittent jaundice. Pancreatic ferment studies were done: Amylase and trypsin present in normal amount. Blood-clotting time, fourteen minutes; control, nine minutes. Weight, 91 pounds.

Sixteen months: 4 1 0. Weight, 97 pounds. Complains of persistent diarrhea, aching in back and ribs.

Nineteen months: 0 0 0. Telephone message from her physician: "C. L. died in August, 1919. The mass in epigastrium had reappeared, increasing markedly in size, and she had deep jaundice with chills and fever. Diarrhea, nausea and vomiting were severe and predominating symptoms during the last two months of her life."

Case VIII.—C. L.; History No. 36960; age, forty-three years; married; editor. Jaundiced; average build.

Acute cholecystitis; chronic cholecystitis; chronic cholangitis; calculi in gall-bladder and common duct; pancreatic lymphangitis; cirrhosis of liver.

Chief Complaint. Jaundice; pain in epigastrium for six weeks.

Present History. Sudden onset six weeks ago.

Pain in epigastrium, cramp-like, severe; localized to epigastrium, with occasional radiation around costal margin to back. Not related to food intake.

Tenderness in right upper quadrant.

Jaundice five weeks. This has continued, deepening gradually.

Clay-colored stools and dark urine.

No chills or sweats.

Past History. Seven months ago similar attack, but no jaundice. Five months ago similar attack, with jaundice; lasted four to five days. Pain very severe. Typhoid at eighteen years.

Px. Well developed, chronically ill, deeply jaundiced.

Abdomen: Distended. Tenderness marked over gall-bladder, where a small mass is felt.

Coagulation time, eleven minutes five days ago; thirteen minutes three days ago.

X-rays show gallstones.

Wassermann negative and ++.

February 2, 1918. Cholecystectomy; choledochostomy; hepaticus drainage.

Findings were complicated: (1) Because of dense adhesions about ducts and thickening of wall of common duct; (2) anomalous situation and length of cystic duct, its terminal 2 cm. lying anterior to and in contact with common duct.

The gall-bladder was very tense, distended, filled with pus and many gallstones of small mulberry type. Walls markedly thickened. Ampulla was greatly dilated and closely fused to cystic and common duct in a dense layer of fibrinous adhesions. The common duct, contrary to expectations and to the usual pathology of common duct obstruction, was not dilated, but this was due to the marked thickening and infiltration of the walls. There were several small mulberry stones in the common duct and in the cystic duct. The lymph nodes along the gastrohepatic omentum were greatly enlarged. The pancreas showed a hard induration in the head along the course of the duct. This was not as hard as carcinoma, but certainly caused some compression of the duct. The bile coming out of the hepatic ducts was pale. The liver was cirrhotic and gave impression of being hard and containing much connective tissue.

Pathological Report, No. 20633. Empyema of gall-bladder; Chronic cholecystitis; cholelithiasis.

Culture, Gram-negative bacillus.

Ninth day: Began to ooze. Serum given intramuscularly.

Tenth day: Oozing continued. Blood transfusion. Bleeding ceased in twenty-four hours.

Eleventh day: Oozing resumed.

Twelfth day: Oozing severe; 300 cc of 0.2 per cent calcium lactate given intravenously in glucose. This was followed by a chill and reaction but oozing stopped.

Sixteenth day: Oozing resumed, but controlled by calcium lactate.

Twentieth day: Large slough came away. Biliary fistula continues.

Twenty-fourth day: Oozing. Calcium lactate.

From the twentieth day condition gradually grew worse, patient losing in weight and strength. Marked asthenia, anorexia, nausea and vomiting with hemorrhage. Stomach dilated; marked gaseous distention. Stools foul, clay-colored. Given bile by gavage (his own) and later he drank it.

Thirty-fifth day: He complained of great epigastric distress; had volumes of gas come up and felt great nausea and vomited. A thorough clearing out with colon irrigation and pituitrin made him feel much better. Profuse biliary fistula until thirty-sixth day.

Thirty-sixth day: Biliary fistula suddenly closed. From then on he showed a steady improvement; stools became colored; he was able to eat and gained in strength.

Forty-seventh day: Gained 9 pounds in last week. Goes to Atlantic City.

Follow-up notes:

One month: 4 2 2. Steadily improving; gaining in strength; no indigestion.

Eight months: 4 4 4.

Twenty-four months: 4 4 4. No recurrence of indigestion, pain or jaundice. He has been showing symptoms of alcoholic dementia; he is a dipsomaniac.

Forty-two months: 4 4 4. Has no trouble with his digestion. His alcoholism is, however, now a very serious condition. He is insanely jealous of his wife and maltreats her unbelievably.

Case IX.—F. C.; History No. 37883; age, sixty years; married; furrier; children, 1. Emaciated; jaundiced.

Chronic cholecystitis; calculus in gall-bladder (combination stone); biliary cirrhosis and ascites; asthenia.

Chief Complaint. Pain in right upper quadrant for twelve months. jaundice for eleven months.

For many years has had attacks of pain with indigestion.

Twelve months ago, after indiscretion in diet, she had one of her

attacks of indigestion and dull pain in epigastrium. Two days later she noted she was jaundiced. This has persisted ever since, with remissions.

Pain comes on in epigastrium after eating too much, at times radiating to back. No nausea or vomiting. Bowels regular, with light stools. Loss of weight, 50 to 60 pounds. Asthenia.

Came to Presbyterian Hospital three months ago, but refused operation.

Px. Thin, poorly nourished, emaciated, jaundiced, very nervous. In right upper quadrant there is a bulge which is apparent above the rest of the abdominal contour. This corresponds to a mass felt as enlarged liver.

Blood-clotting time, thirteen minutes. 300 cc of calcium lactate infusion, 0.2 per cent.

X-rays show shadow 4 by 3 cm. in region of common duct opposite second and third vertebræ.

Wassermann negative.

Operation, June 22, 1918: Cholecystostomy.

On opening peritoneum free fluid was found, bile-tinged and 2 liters aspirated. Liver was enlarged to level of umbilicus and corresponds to the mass felt before operation. It was uniformly enlarged, not nodular and had appearance of hypertrophic cirrhosis. A mass was found on under surface of right lobe of liver, densely adherent to duodenum and stomach. It consisted of gall-bladder and omentum. Tip of gall-bladder was pearly-white and nodular and was taken at first to be carcinoma, but section through this tissue showed only chronic inflammation as did node from omentum. Gall-bladder when opened showed a dense thick wall and the dilated lumen was occupied by a very large gallstone measuring 4 by 3.5 by 3 cm. There was also pus about this stone. Walls of the gall-bladder were markedly degenerated, showing calcareous plaques, and infiltrated with calcium. This stone and the mass attached to it was evidently the cause of the common duct obstruction and may have caused some portal obstruction by pressure on gastrohepatic ligament. The cystic duct was patent and a clear golden bile came away on removing the stone and continued to pour out during the operation. No stones were felt in the common duct. Pancreas was definitely pathological, hard at head. Because of her jaundice and the dense adhesions about the cystic duct, cholecystectomy was not attempted.

Pathological Report, No. 21443. Chronic cholecystitis, cholelithiasis, cirrhosis of liver. Cultures, Bacillus coli communis.

Postoperative course: Complicated by profuse biliary discharge, persistent biliary fistula, severe infection of wound, marked asthenia and anorexia and apathy.

Patient was discharged on thirty-seventh day, with persistent biliary fistula and asthenia. Weight, 112 pounds. Prognosis considered bad.

August 8, 1918: Six weeks. For past week she had several brown stools and for three days fistula closed, but it reopened and again had clay-colored stools.

Two months: 4 4 2. For ten days stools were normal and fistula closed. Fast regaining her strength. Has fine appetite. Gained 10 to 12 pounds.

Ten months: 4 4 4. Weight, 154 pounds. Shown at Surgical Society. Feels well in every way. No recurrence of any symptoms. Liver edge 2 cm. below costal margin.

Fifty-six months: 4 4 4. Weight, 185 pounds. Has not a digestive disturbance of any kind. No recurrence of pain or jaundice. She is proprietress of fur store and works as hard as ever.

Case X.—A. A.; History No. 42952; age, fifty-one years; single. Obese; jaundiced.

Chronic cholecystitis; calculi in gall-bladder and common duct; pancreatic lymphangitis and asthenia.

Chief Complaint. Pain in upper abdomen.

Seven weeks before admission sudden attack of stabbing pain in upper abdomen, localized. Eased by cold applications and belching.

Twelve hours later tenderness across upper abdomen. Nausea and vomiting every half-hour during night.

Three days later jaundice, which has persisted. Symptoms of digestive disturbance for seven weeks; belching; bloating.

Past History. Patient has had four attacks: First, sixteen years ago; last, seven years ago. No typhoid. No pregnancies. Still menstruating.

Px. Obese; jaundiced. Tender in right upper quadrant. Liver palpable.

Urine: Albumin, pus, bile.

Blood Wassermann not reported. Clotting-time, seven minutes.

Operation, August 14, 1919: Choledochostomy, cholecystectomy (gas and ether).

Anteoperative diagnosis: Chronic cholecystitis; stone in common duct.

Postoperative diagnosis: Same, plus chronic pancreatitis.

Gall-bladder markedly shrunken; atrophic. Cystic duct at junction with common duct showed a thickening and formed part of a constriction with common duct which contained a triangular-shaped stone 6 mm. in diameter; two other smaller ones. Head of pancreas

was thickened and hard at the head. Lymph nodes enlarged in gastrohepatic omentum. Bile from common duct clear.

Incision: Hockey-stick. Drain: Hepaticus and cigarette.

Pathological Report, No. 23320. Chronic cholecystitis; cholelithiasis.

Complications: Asthenia, anorexia, acholic stools.

Postoperative course: Complicated with nausea and vomiting, anorexia, asthenia, distention.

Three months: 4 4 4.

Twelve months: 4 4 4.

Case XI.—R. S.; History No. 50906; age, forty-five years; widow; children, 6; miscarriages, 3. Average build.

Chronic cholecystitis; chronic pancreatitis; pancreatic asthenia.

Chief Complaint. Pain in epigastrium, three months.

Present Illness. Began three months ago.

Pain in epigastrium, squeezing in character, radiating to back. Always brought on by protein food one-half hour after meals, lasting an hour. Always worse when she was nervous or tired. Relieved by hot applications.

Nausea and vomiting and belching of gas with pain. Never vomited blood. No jaundice.

Tenderness in epigastrium. Bowels very constipated in past three months. Lost 12 pounds in three months.

Past History. Always well.

Px. Neurotic, thin Jewess. Teeth very foul. Tenderness over epigastrium across abdomen.

Test-meal: Fasting, free HCl, 84 per cent; Ewald, 80 per cent. Fasting, free HCl, 90 per cent.

Duodenal bucket: Bile always acid.

X-rays: No evidence of obstruction in colon.

Operation, August 4, 1921: Cholecystectomy, choledochostomy (gas and ether). Pancreas hard; nodular over head and tail of pancreas. Common duct was dilated 1 cm. Gall-bladder thickened. Right rectus incision. Rubber tube in common duct and Morrison's pouch.

Anteoperative diagnosis: Gastric ulcer; chronic cholecystitis; chronic pancreatitis.

Postoperative diagnosis: Chronic cholecystitis and pancreatitis.

Pathological Report, No. 26510. Chronic cholecystitis; cholelithiasis. Culture, hemolytic Staphylococcus aureus in gall-bladder and bile.

Course: Complications: Pancreatic asthenia, subhepatic abscess (Bacillus coli).

First to fourth day: Much distention, nausea and vomiting.

Eighth day: Began to complain of asthenia and anorexia. Stools clay-colored.

Tenth day: Would not take any nourishment. Discharge of bile profuse.

Twelfth day: Feels much stronger.

Fourteenth day: Appetite returning.

Twenty-first day: Tube removed. Steady convalescence.

Five months: 4 4 4. Weight, 97½ pounds.

Fifteen months: 4 4 4. Weight, 122 pounds.

Twenty-one months: 4 4 4. Weight, 115 pounds. Blood-pressure, 168/90. Feels well; no indigestion. Bowels regular without medication. Has never taken cathartic since leaving hospital.

Case XII.—A. H.; History No. 40637; age, thirty years; married; children, 1; pregnant. Jaundiced.

Chronic cholecystitis; calculus in gall-bladder; acute pancreatitis.

Chief Complaint. Attacks of pain in epigastrium.

Fifteen months ago, while pregnant, began to have attacks of pain.

Pain: Severe in epigastrium, colicky, radiating to back and right shoulder. Eased by vomiting, belching. During first attack was jaundiced. Has had twelve attacks.

Four months ago had a severe attack. Two months ago had a soreness in right shoulder and right upper quadrant. Marked interval digestive disturbances: Bloating, belching, epigastric and right upper quadrant distress after meals.

Now pregnant two to three months.

Past History. Appendicectomy eight years ago. Rheumatism at twelve years.

Px. Well developed and well nourished. Good color. Breasts large. Heart, mitral insufficiency.

Abdomen: Thick-walled, soft. Old scar in right lower quadrant. Tenderness in epigastrium and over pancreas. Deep pressure causes severe pain to radiate to back.

Wassermann negative.

Operation, January 27, 1919: Cholecystectomy. Incision: Hockey-stick. Drain: Rubber tube to Morrison's pouch.

Complications: Acute pancreatitis, pregnancy, acute ileus, pancreatic asthenia.

Gall-bladder was thickened, showed old fibrous adhesions and some perihepatitis. One stone was found in gall-bladder. Lymph nodes were markedly enlarged at junction of cystic and hepatic ducts and along gastrohepatic omentum and over head of pancreas. No stones felt in ducts. Stomach and duodenum O.K.

Pathological Report, No. 22288. Chronic cholecystitis; cholelithiasis. Culture, hemolytic Staphylococcus aureus.

Postoperative course: Day of operation, severe vomiting.

Second day: Jaundiced; severe pain; distended.

Fourth day: Stools negative for bile.

Sixth day: Profuse biliary discharge; vomiting.

Seventh day: Nausea and vomiting.

Eighth day: Distended.

Ninth day: Hungry; discharge profuse.

Ninth to eighteenth day: Several stools each day, clay-colored. Fistula shows autolysis of skin. Stools have shown bile at times.

Eighteenth day: Had a chill. Bile discharge increased. Anorexia, nausea and vomiting, severe headache and much bloating.

Twenty-third day: Pain and tenderness in right upper quadrant. Began to bleed from fistula.

Twenty-sixth day: Clotting-time, thirty-five minutes. Stool negative for bile. Slightly jaundiced. Calcium lactate solution, 0.2 per cent given.

Twenty-eighth day: Nausea and vomiting; clotting-time, forty-two minutes.

Autopsy, No. 8872. Acute diffuse cholangitis; hematoma in duodenum and retroperitoneal tissues; necrosis of common bile duct; acute intestinal obstruction; hematoperitoneum; pregnancy; pancreatic sclerosis; icterus.

Blood in both nostrils. Bloody discharge from vagina. In right upper quadrant are dense adhesions to the right costal margin, surrounding a sinus leading down to gall-bladder bed. The anterior surface of the liver (right lobe) is covered with coagulated blood. This clot extends up to dome of right diaphragm. At the beginning of the jejunum the intestines are distended and filled with a firm semisolid mass. This mass is retroperitoneal as well. The retroperitoneal tissues around the duodenum and head of pancreas are diffusely infiltrated with blood, forming a hematoma.

The fatty tissue around the pancreas and the surface of the pancreas itself show several small circumscribed areas of fat necrosis. The pancreas is firm. On section, small hemorrhagic areas are noted. These become more numerous as the head of the pancreas is approached.

Duodenum: The mucosa is hemorrhagic. The duodenum is enormously distended, the result of a submucous hemorrhage completely shutting off the lumen of the duodenum. Mucosa of duodenum shows numerous petechial hemorrhages. Gall-bladder bed is

hemorrhagic, covered with necrotic granulation tissue. On dissecting down to common duct near its central portion it has sloughed. A probe leads into duodenum. Portal vein and hepatic artery are intact.

Microscopic. Pancreas: Fat necrosis with some fresh hemorrhages near them. In one section postmortem change is present. These are as of recent necrosis of the parenchyma with polymorphonuclear leukocytes about the periphery. The islands are negative. Old fibrotic changes not made out.

Liver: In a few of the portal areas there are occasional polymorphonuclears. Some of the bile canaliculi are distended with bile. There are large areas showing cells with no nuclei and shrunken basement membrane. In these areas are large colonies of coarse bacilli (Bacillus welchii(?)), but inasmuch as these areas show very little if any polymorphonuclear reaction, the changes are considered to be postmortem.

Case XIII.—M. M.; History No. 22091; age, forty-nine years; single; housework. Obese.

Carcinoma of pancreas; pancreatic asthenia.

Chief Complaint. Pain in right upper quadrant; jaundice.

Present Illness. Pain began three weeks ago in right upper quadrant, radiating to right shoulder; two weeks ago jaundice began. Indigestion for two years. Epigastric distress with large amount of belching.

Past History. No typhoid. Menopause two years ago.

Px. Obese; jaundiced. Tenderness and spasm in right upper quadrant.

Wassermann: Alc., +; cholesterol, ++++.

X-rays negative for stone.

Operation, August 23, 1915: Cholecystostomy, choledochostomy.

Gall-bladder distended, red; omentum adherent to fresh fibrinous adhesions. Walls thick, edematous, containing thick, grayish, grumous material. No stones found in gall-bladder or ducts. Head of pancreas very hard, lobulated, common duct dilated and contained mucus.

Incision: Hockey-stick. Drain: Rubber tube in common duct and gall-bladder.

Pathological report, none. Cultures of bile sterile.

Complications: Following operation she began to complain of weakness and anorexia and continued to have nausea and vomiting. Developed severe and persistent hemorrhage on sixth day from

wound-stitch holes and subcutaneous tissues. Weakness, prostration, inability to take nourishment increased until fourteenth day, when she died.

Case XIV.—L. K.; History No. 38847; age, forty-one years; separated; children, 8. Jaundice; obese.

Carcinoma of gall-bladder; chronic cholecystitis; calculi in gall-bladder; chronic pancreatitis; acute pancreatitis; pancreatic asthenia.

Chief Complaint. Pain in right upper quadrant. Jaundice.

Present Illness. Onset sudden, two weeks ago with pain.

Pain: In right upper quadrant; severe, cramp-like, radiating to interscapular region; continued for three days.

Jaundice appeared two days after onset of pain and has persisted. Pruritus in last week.

A mass, 9 cm. in diameter, noted by patient in right upper quadrant a few hours after pain came on. This gradually disappeared. During this time she has had much bloating and belching.

Ten years ago a severe attack of general abdominal pain for three to four weeks. No jaundice then. No typhoid.

Px. Obese; jaundiced. Teeth dirty.

Abdominal tenderness along both costal margins more marked on right side. No mass palpated.

Wassermann negative.

Clotting-time, fifteen minutes.

Operation, August 7, 1918: Cholecystectomy, choledochotomy, transduodenal choledochotomy.

Dilatation of stricture of common duct; duodenorrhaphy.

Anteoperative diagnosis: Cholelithiasis; stone in common duct.

Postoperative diagnosis: Calculi in gall-bladder; stenosis of common duct; chronic pancreatitis; chronic cholecystitis.

Gas and ether.

Gall-bladder was extremely distended and S-shaped. The neck of the gall-bladder was dilated, the pouch overlying the common duct. Gall-bladder contained clear mucus with many gallstones. Cystic duct was closed and showed an anomaly. This consisted in the prolongation of the cystic duct, parallel to and to outer side of common duct, emptying into latter in the retroduodenal aspect of the common duct. Lymph nodes along the dilated common duct were enlarged, especially around head of pancreas. Common duct showed stenosis in the intramural portion, a vertebrated probe passing with difficulty into the duodenum. Head of pancreas was hard, enlarged and showed marked lymph-node enlargement. No gross pathology

noted in the liver. Drain: Catheter into duodenum through common duct, double tube to Morrison's pouch. Incision: Right rectus.

Pathological Report, No. 21653. Carcinoma of gall-bladder, calculi in gall-bladder. Cultures, Gram-negative organisms.

Second day: Nauseated; much biliary discharge.

Third day: Vomited three or four times.

Fourth day: Vomited.

Fifth day: Vomited; lavaged.

Sixth day: Anorexia; asthenia first complained of.

Tenth day: Unable to take any nourishment; says she feels very weak.

Twelfth day: Vomiting; feels weak and tires easily.

Fifteenth day: Oozing profuse. Feels weak and tires easily; vomited.

Sixteenth day: Vomited; seems weaker and more apathetic daily.

Eighteen day: Vomited; had brown movement; very weak.

Nineteenth day: Vomited; pulse very irregular. Died at 5.50 P.M.

Autopsy No. 8831. Necrosis and liquefaction of retroperitoneal tissue around duodenum; necrosis of duct of Wirsung; carcinoma of liver, ovary, head of pancreas and adrenal; chronic pancreatitis with acute exacerbation; necrosis of adrenal.

Around the drainage tract in the right upper quadrant are numerous adhesions. The tract leads down past the bed of the gall-bladder to the common duct and duodenum, where it is continuous with a cavity that extends behind the transverse and ascending colon. This cavity measures 20 by 15 cm., is filled with broken-down blood and pus; its wall is black, necrotic and studded with areas of fat necrosis. The necrotic tissue extends to and includes the lower end of the common duct and head of the pancreas and first half of the duodenum.

Liver: Scattered over the liver, and particularly the right lobe, there can be seen through the capsule white areas, 2 to 12 mm. in diameter. On section these have the appearance of carcinoma metastases.

Pancreas: The head of the pancreas shows a large necrotic area. The duct of Wirsung opens into this area. The consistency of the entire pancreas is markedly increased. Quite a number of congested and hemorrhagic areas are noted on its surface and section. In the head there are noted several hard, white nodules about 1 cm. in diameter. On section these cut with a hard feel and are taken to be carcinoma metastases.

Microscopic sections of the liver show a biliary cirrhosis, an acute but moderate pericholangitis and areas of fatty infiltration.

Pancreas: The architecture is broken up by wide bands of connective tissue. There are areas of hemorrhage into the glandular tissue. One section shows tumor tissue.

Case XV.—T. B.; History No. 43823; age, sixty-two years; blacksmith; married. Jaundiced.

Carcinoma of pancreas (body).

Chief Complaint. Vomiting and pain in stomach for five weeks.

Present Illness. One year ago he began to lose his appetite and during this time he had two or three vomiting spells. Five weeks ago he began to have attacks of:

Pain: Griping, in epigastrium; localized; after eating.

Nause and vomiting: Has vomited every meal, with heartburn. Lying on back relieved pain and helped vomiting.

Jaundice: Began to appear one week ago.

Loss of weight: 20 pounds in two months.

Px. Loss of weight; jaundice. Blood-pressure, 145/80. Palpable liver. Mass beneath right rectus(?) Tenderness in epigastrium and to right of umbilicus.

X-ray, October 28, 1919: No visible deformity of stomach; empty in six hours. November 11, 1919: Complete pyloric obstruction; definite deformity.

Red blood cells, 4,900,000; hemoglobin, 80 per cent; white blood cells, 6200; polymorphonuclears, 60 per cent.

Gastric analysis, fractional. Free HCl, 24, 19, 15, 18.

Note (November 9, 1919).—Anorexia, development of pyloric obstruction, absence of clay-colored stools, absence of palpable gall-bladder, with no previous history of gall-bladder disease, point strongly to carcinoma of pylorus rather than carcinoma of pancreas, gall-bladder or ducts. Exploratory operation advised.

Operation, November 12, 1919: Exploratory celiotomy (novocaine, twenty-seven minutes).

Anteoperative diagnosis: Carcinoma of pylorus.

Postoperative diagnosis: Carcinoma of pancreas.

On opening the peritoneum no free fluid was found. Stomach and pylorus were examined with special care and found normal. Gall-bladder was moderately distended, but did not extend beyond costal margin. Common duct was moderately distended. No stones were felt in gall-bladder or ducts. Gall-bladder not chronically inflamed. The lesion was a carcinoma of the pancreas, encroaching upon the common duct with metastases in lymph nodes, in gastrohepatic omentum and portal fissure. The posterior wall of stomach was somewhat

adherent to the pancreatic growth. No lesion could be found to account for the pyloric obstruction. Because of the advanced lesion, further procedure was deemed unwise.

Complications: Asthenia, vomiting, apathy.

Postoperative course: Vomited practically everything given. Glucose infusions, 5 per cent, kept him alive for a time. Blood-pressure on tenth day, 85/60.

Died on fifteenth day.

Case XVI.—H. J.; History No. 55957; age, thirty-four years; single; maid. Emaciated; jaundiced.

Carcinoma of pancreas; pancreatic asthenia.

Chief Complaint. Jaundice and loss of weight, three months.

1. Onset of nausea and vomiting on ocean three months ago.

2. Jaundice appeared—gradually, persistent, increasing.

3. No history of biliary colic or preceding interval digestive disturbances.

4. Improvement in appetite in past month. Ability to eat food containing fat.

5. Absence of fatty, greasy stools.

6. Presence of a large, palpable, pear-shaped mass in right upper quadrant, movable from side to side.

7. Progressive loss of weight, 37 pounds in three months.

Because of 2 and 6, obstruction was considered below cystic duct; 4 and 5 favored carcinoma of common duct rather than carcinoma of pancreas.

Past History. Hysterectomy at Bellevue Hospital four years ago. Fibroid (?) No typhoid or malaria. Influenza two years ago.

Px. Emaciated jaundiced. She impresses one as a carcinoma that has lost all hope.

Blood-pressure, 112/68.

Abdominal scar in suprapubic region. Liver, 10 cm. below costal margin—firm, smooth, not hard. At lower margin is an elongated, firm, cystic bladder, movable from side to side.

Red blood cells, 4,600,000; hemoglobin, 78 per cent; white blood cells, 6800; polymorphonuclears, 65 per cent.

Bleeding-time, two minutes forty seconds. Coagulation time, eight minutes; control, five minutes. Group No. 1.

Wassermann negative. Blood cholesterol, 0.3 per cent.

Operation, January 16, 1923: Cholecystgastrostomy (novocaine). Cause of obstruction was found to be carcinoma of head of pancreas, involving upper and outer part of the head. Gall-bladder distended; free from stones; presented next to stomach. Section removed for examination was lost in operating-room.

Postoperative course: Patient stood operation well. Drowsy; comfortable.

First day (postoperative): Pulse, 120; poor quality. Marked pallor. No evident bleeding. Vomited bile-stained material. Very apathetic. Nauseated; asthenic.

Second day: Pulse weak. Blood-pressure, 78/56. Vomiting and nausea. Marked apathy.

Died at 7.15 P.M.

CASE XVII.—B. W.; History No. 42817; age, fifty-three years; widow; children, 10; miscarriage, 1. Thin; jaundiced.

Carcinoma of gall-bladder and common duct; calculus in gall-bladder and common duct.

Chief Complaint. Jaundice, six weeks.

Past History. For thirty years has had attacks of pain, epigastric, radiating to right shoulder and back; usually severe, cramp-like. Attacks last from thirty to forty-five minutes and come on at irregular intervals. Attacks came on before marriage but became worse during first pregnancy. Never jaundiced until six weeks ago. Frequently has epigastric distress and bloating and belching. No typhoid.

Six weeks ago had constant right upper quadrant pain and began to be jaundiced. This has continued. Stools clay-colored. Has lost 15 pounds in weight.

Px. Chronically ill; jaundiced intensely.

Abdomen: Skin loose, flabby. Right upper quadrant more prominent than other quadrants. Liver enlarged and edge at level of umbilicus. What is thought to be gall-bladder is felt just below liver edge; tender.

Blood Wassermann: negative. White blood cells, 4,000,000; polymorphonuclears, 80 per cent; red blood cells, 9100; hemoglobin, 70 per cent.

Blood sugar, 1.31 gm. per liter. Coagulation-time, eighteen minutes; control, ten minutes.

Bleeding-time, four minutes.

Blood-pressure, 110/70.

250 cc of 0.2 per cent calcium lactate; five hours afterward coagulation time was eleven minutes.

August 4, 1919: Cholecystectomy, choledochostomy.

Anteoperative diagnosis: Chronic cholecystitis; calculus in common duct; chronic pancreatitis.

Postoperative diagnosis: Same, plus carcinoma of common duct. No stones in ducts.

Liver was greatly enlarged, especially right lobe. Not grossly cirrhotic. Gall-bladder was seven or eight times the normal size and divided into at least two main compartments. A third pouch was found. This at first was thought to be dilated common duct, but on making a small nick in it nothing but a clear fluid mucus poured out, so this was considered to be another pouch of the gall-bladder adherent to common duct. This impression was strengthened by the fact that it was dilated, and before opening it, a hard mass was felt in the lower aspect of the common duct. When the pouch was trimmed it was found that the hepatic ducts dilated to admit a finger, emptied into this pouch, and that at the lower end a hard, crater-like opening with everted edges led down for a short distance toward the duodenum. This was a carcinomatous stricture of the common duct. No stones were seen or felt in the common or hepatic ducts. Nothing but clear mucus escaped from the hepatic ducts. There were several hard, shotty nodules along mesial aspect of the common duct.

The gall-bladder in two places showed constrictions with marked puckering. Tissue here was hard and appeared to involve the liver, but it was not easy to say whether this was scar tissue or carcinoma. There were 100 to 200 stones in the gall-bladder.

Pathological Report, No. 23173. Carcinoma of gall-bladder; chronic cholecystitis; cholelithiasis; carcinoma of the common duct.

Postoperative course: Nausea, vomiting and asthenia continued throughout, although she did reëstablish some bile in duodenum. Went home on sixteenth day. Taken by family as they were told she had only short time to live.

Patient died two months later at home.

Case XVIII.—R. W.; History No. 56638; age, fifty-three years; married; engineer. Admitted March 28, 1923.

Carcinoma with metastases following carcinoma of gall-bladder.

Chief Complaint. Anorexia for six weeks; jaundice, four weeks; loss of weight, 50 pounds in eight weeks.

Family and *personal* history irrelevant.

Past History. Irrelevant except for two attacks of anorexia five and two years ago respectively.

Present Illness. For six months he has been feeling "run down" and has had frequent colds. Eight weeks ago began to cough up dark phlegm "from the throat" every morning. About six weeks ago his appetite began to fail; anorexia has steadily increased until now he eats almost nothing. For the past four weeks he has had

steadily deepening jaundice. Stools have been clay-colored and urine dark since onset. No pain, nausea or vomiting. Slight chilly sensations at times. No real chills. No noteworthy loss in strength, but he has lost about 50 pounds in weight in eight weeks. Nocturia four to five times since onset of present illness; never before.

Px. Skin very bright yellow, as are all visible mucous membranes. Considerable pyorrhea alveolaris. Lungs and heart show no abnormalities. Blood-pressure, 135/80.

Abdomen: A hard mass; presumably liver, is felt extending about 10 cm. below the costal margin in the right upper quadrant and about 5 cm. below in the left upper quadrant. The edge is difficult to define and not definitely nodular. Slight epigastric and right costovertebral tenderness. Hard and enlarged axillary lymph nodes.

Rectal: Negative.

Laboratory Findings. *X*-ray showed hypertonic stomach; hepatic flexure of colon pulled to left.

Liver-function test showed marked retention of dye in blood stream.

Urine: Albumin, faint trace; bile present.

Stools: No bile present.

Blood count: Normal.

Wassermann negative.

Blood-clotting time: Patent, nine minutes; control, three and a half minutes.

Serial test-meal: Fasting expression, free HCl, 60 per cent; total acid, 65 per cent. One hour free HCl, 40 per cent; total acid, 40 per cent.

Operation, Dr. St. John: Cholecystostomy; excision of specimen. Incision: Right rectus. Gall-bladder distended with "white bile;" wall thickened and indurated. Pancreas hard, with several enlarged lymph nodes in region of head. Cholecystostomy performed. Section of wall of gall-bladder showed carcinoma, probably primary in gall-bladder.

Fairly easy recovery from operation. Drainage of bile averaging about 1000 cc per day; character of bile changing from thin straw-colored fluid to thicker yellow material. Jaundice a brownish-yellow.

The patient's blood-pressure varied from 116/70 to 135/80 during the week of observation before operation. The afternoon after operation pressure was 100/62, the next day 122/74, the next day 118/78. On the fifth day after operation he began to complain of asthenia, nausea and vomiting. Blood-pressure dropped abruptly to 60/30 and the next day 40/, seventh day, 50/. His blood-pressure continued low until the eighteenth day, when it rose to 100/80, although

his loss of weight and cachexia were very marked. The day before death pressure was still 100/83 and showed a definite increase over the period when his symptoms of asthenia were the most marked.

He died on the twentieth day. Autopsy was not obtained.

References

1. Robson, Mayo, A. W., and Cammidge, P. S.: The Pancreas, its Surgery and Pathology, p. 409.
2. Hotchkiss, Lucius W.: Providence Medical Journal, xv, No. 3, 127.
3. Oser, L.: Notnagel's Encyclopedia of the Practice of Medicine, 1903, lx, Diseases of the Pancreas, Adrenal and Liver, p. 147.
4. Loc. cit., p. 162.
5. Loc. cit., p. 154.
6. Diss. Inaug. de quibusd., Pancreatis Morbis, 1817, p. 26.
7. Battersby, F.: Gaz. méd. de Paris, 1844, xxxix, 617.
8. Ludolf: Dissert., 1890.
9. Halzmann, M.: München. med. Wchnschr., 1894, No. 20, p. 389.
10. Caparelli: Arch. ital. de Biologie, 1894, xxl, p. 398.
11. Guidiceandra: Sulla calcolosi del pancr. Policlin., 1896, pp. 33 and 126.
12. Friedrich: Nothnagel's Encyclopedia of Practice of Medicine, 1903, lx
13. Loc. cit.
14. Fitz, Reginald H.: Trans. Cong. Am. Phys. and Surg., 1903, p. 36.
15. Whipple, A. O.: Ann. of Surg., Nov. 1919, p. 484.

DISCUSSION ON THE PAPERS OF DRS. CRILE, MAC LAREN, BALFOUR AND WHIPPLE

Dr. W. J. Mayo, Rochester:

I am going to confine my remarks to the first paper, that by Dr. Crile. I wish to echo what he has said in regard to our lack of knowledge of the liver. I believe that many of the catastrophies and disasters that are connected with the surgery of the upper abdomen have to do with the liver more than anything else.

I wish to call attention again to what Dr. Crile said in regard to the difficulty of diagnosis in these cases.

The sense of touch I learned a long time ago. When I examine a patient's gall-bladder I can say I do not feel any stones, although I have learned that there may be some that I could not feel.

If the gall-bladder gives symptoms, and yet no pathological condition is evident on the outside of the gall-bladder, I have tried making an opening in it and exploring, but have sometimes ended by removing the organ on account of the damage that I had done to it in attempting to locate the disease. In operating in the vicinity of the opening of the cystic duct, I have put my finger down to it, but could not see or feel it.

We have to admit that there is a small percentage of cases in which the gall-bladder has to be removed on account of suspicion. This is unfortunate.

In a series of some 6000 cases, in the microscopical examinations carried out by Dr. MacCarty, I think only 17 cases failed to show sufficient disease to warrant its removal.

Cholecystectomy has a larger mortality rate than cholecystostomy, for the reason that I have mentioned. I am very happy to have the opportunity to operate on a patient a second time, rather than to lose the case at the first operation. Whatever the case is, when the risk is greater from cholecystectomy than from cholecystotomy, I do the latter operation with the expectation that 50 per cent will have a second operation. I am now removing gall-bladders on which I did a cholecystotomy more than twenty years ago. I like the Bevan incision, and in appropriate cases have been using it since 1898.

As to the question of hemorrhage, one must look out for bleeding from cholecystotomy from the margin of the gall-bladder itself. Hemorrhage may not appear until the day after the operation, but if it is red the only safe thing to do is to pull the gall-bladder up and

you will find that is where the hemorrhage comes from. After having lost several patients, as I supposed from jaundice, I am very careful now to guard that edge, so that I do not get hemorrhage from that source at present.

One thing more, and that is in regard to decompression, which Dr. Crile mentioned. I do not know whether this is the proper explanation. We all meet with a certain number of cases. We do not know whether it is malignant disease or not, but we think it is. We feel a distended gall-bladder. If we do a cholecystotomy the patient will linger along, and it is surprising how well some of these patients do. I think that a cholecystogastrostomy is a comparatively safe operation, even in the badly jaundiced cases, and I do not believe that the patients have any inconvenience from bile entering the stomach. This is much easier and safer to do than a cholecystoduodenostomy.

Dr. Howard Lilienthal, New York:

I have always been interested in the subject of the removal of the diseased gall-bladder. Dr. Crile announces that there is a difference of about 30 per cent in mortality between cholecystectomy and cholecystostomy. My feeling is that when it is necessary to do a second operation after cholecystostomy, and the patient dies, it should go to the score of the original operation. There is no particular reason in placing it solely to the debit of cholecystectomy

I do not agree with Dr. Bevan about beginning at the fundus in difficult cases; if it is important to begin at the fundus, then why put the subjects of the easy cases in extra jeopardy? I have found it much easier and safer to begin at the fundus in all cases.

One other point, and that is the matter of a primary jejunostomy in these cases. If it is possible to put in a duodenal tube through the mouth, I do not think it is justifiable to do a jejunostomy. It is better to use the Einhorn tube, which can be worn for months and which will give the stomach perfect rest. Jejunostomy has a distinct mortality. Therefore I would suggest strongly that instead of adding the complication of a jejunostomy that we should make use of the duodenal tube.

Dr. Leonard Freeman, Denver:

I want to say a word about Dr. Balfour's paper: There can be no question of the value of the cautery method in the treatment of ulcers. It simplifies what might otherwise be considered a complicated and difficult operation. Furthermore, we should not forget

that it has a profound effect upon malignant conditions. A case of my own illustrates both of these points—a man with an ulcer of the lesser curvature of the stomach. His general condition was of such a character and the ulcer was so situated that it seemed impossible to do a radical operation. I used the cautery to cut out the ulcer, had it examined and it proved to be malignant. I firmly believed that the man would soon die, but he did not. After three years he is still alive and perfectly well.

In spite of the fact that this method has its advantages, it also has its dangers, particularly the danger of secondary hemorrhage at the time of separation of the sloughs. I have been unfortunate enough to have 2 such cases; 1 in which hemorrhage took place on the fifth day and the other on the eighth day. They were both ulcers on the posterior wall of the stomach and 1 was adherent to the pancreas. One of the patients bled so copiously and vomited so continously that he broke open the abdominal incision on the eighth day. He got well in spite of this misfortune. The other patient died very promptly. This danger, of course, is not great. I presume that I have been particularly unfortunate. My experience would not deter me from using this valuable method in appropriate cases, but it serves to make me more cautious in its use when a resection can be done with equal advantage.

Dr. E. Graham, St. Louis:

I just want to confine my remarks to Dr. Whipple's paper. I have been interested in lesions of the liver associated with the gall-bladder as well as of the pancreas. I enjoyed this paper, but I am sorry he did not tell us more about the pathology of the liver. I want to ask if he will be kind enough to tell us the final pathology at the autopsies, and a little more, if possible, about the pathology of the liver at the time of the operation. I am wondering if some of these symptoms might not be ascribable to a disturbance of liver function instead of being due exclusively to a disturbance of the pancreas.

Dr. Charles H. Peck, New York:

Referring to Dr. MacLaren's paper, we have had 4 instances in the last few years at the Roosevelt Hospital, in women, aged seventy-two, fifty-two and thirty-one, and a man, aged twenty-eight years. In 3 the diagnosis was of gall-bladder disease only and the ulcer was not recognized until the time of the operation. In 3 the combined operation was done—removal of the gall-bladder and posterior gastroenterostomy.

In 1 of the women, aged thirty-one years, the duodenal ulcer was a comparatively small anterior one and a local excision without gastroenterostomy was done. Three of the patients made good recoveries. The woman of fifty-two died from a relatively late complication at about the ninth day—a suppurative parotiditis which was followed by pneumonia. I feel that doing the combined operation is perhaps not wise in these cases as a routine; if we had done less in our fatal case we might have avoided the result, although the complication was one that may be encountered in any abdominal operation.

I agree with the rest of the speakers in using the Bevan incision. The vertical incision prolonged obliquely up toward the ensiform cartilage is sufficient in most gall-bladder work, keeping to the inner third of the rectus muscle. I usually get through without dividing more than one of the motor nerves by retracting those at the upper and lower ends of the wound before dividing the thin transverse muscle or its aponeurosis.

Dr. John H. Gibbon, Philadelphia:

I was delighted with Dr. Crile's paper, and particularly because he stated definitely a type of gall-bladder disease in which we should not remove the gall-bladder. I am convinced that a great many gall-bladders in the hands of most surgeons had better be left in and the gall-bladder drained. I am equally convinced that a cholangitis or the presence of stones in the common duct are in most cases contraindications to cholecystectomy. If these patients come back with a recurrence of symptoms it is easier to handle them if the gall-bladder is present.

A proper "follow-up," or, better, a few hours spent in the service of a good gastroenterologist, I think, will fortify this opinion. I said recently that I was removing one-half the gall-bladders, but I found I was removing 68 per cent. We do not want the idea to go abroad that all gall-bladders must come out. This is a mistake. I have had the same experience that Dr. Crile has had as to leakage after cholecystectomy without a drain. I lost one patient from leakage.

In regard to diagnosis, I think that the *x*-ray has shown us that it is sometimes unreliable. If the roentgenologist is able to outline the gall-bladder I have learned not to think very much of it, because I have seen some normal gall-bladders visualized.

I was interested in Dr. Whipple's paper because I had two patients who developed similar symptoms. One came back to the hospital after her operation for gallstones with symptoms of anorexia and

vomiting, and she died. At the postmortem we found a pancreatic abscess. The other case was one of gall-bladder infection. I removed a number of stones; the patient developed the same symptoms and I reopened and drained an abscess of the pancreas. He died. I do not think Dr. Whipple told us anything about the pathology of those cases that went on to autopsy. I hope he will, because it would be interesting to know what these conditions were.

Dr. Miles F. Porter, Fort Wayne:

I should like to say one word in regard to Dr. Balfour's paper, and that is to ask him whether or not he has ever been satisfied with a cautery excision of a stomach ulcer and the closure of the wound without any further operative procedure. My experience has been limited, but insofar as it has gone, it has been very satisfactory in doing this. For instance, you will get one of those ulcers now and again in which the stomach-emptying is rapid and in which an excision can be made without trouble, and I cannot understand in such cases why we should do a gastroenterostomy. I would like to know whether he has had any experience, what it has been and what his advice would be.

Regarding Dr. Crile's paper, his first conclusion, I think, all surgeons will consider is a maximum, and I fancy that the vast majority of them, at least in this body, regard that statement as an aphorism. It would be a godsend for patients in general, surgical as well as medical, if the whole profession would regard it as a platitude. Of course, you must individualize your patient and fit the operation to his case and not the patient to your particular idea of correct operative technic.

I should like to ask Dr. Crile just what he means and how he accomplishes the restoration of the internal respiration and keeps it there, and what his gauge is as to the success he attains? I would like to ask him to explain more explicitly what he means by decompression of an intermittent character. My own experience has been that if you put a drainage tube in the gall-bladder or put one in the common duct, your subsequent drainage will be intermittent or remittent in spite of what you do. This is the natural outpour of bile. I cannot understand how he can accomplish that.

One other thing that I would like to say: I think I entirely agree with Dr. Crile's closing statement concerning the advisability of cholecystectomy as compared with cholecystostomy, if he means by this the local situation and the general situation. If he means any good surgical risk ought to have his gall-bladder removed, I dis-

agree with him. I am still old-fashioned and regard the gall-bladder as an important organ, and I believe that the local condition, regardless of the general condition, is often the one which should determine the nature of the operation.

Dr. Fred B. Lund, Boston:

There are ulcers and perforations of the duodenum resulting from causes outside the stomach, such as disease of the gall-bladder. In this connection I wish to mention a case of a woman with an enormously distended stomach with ulcer at the junction of the second and third portions of the duodenum. The duodenum was adherent to the liver and gall-bladder. I did a posterior gastroenterostomy. That afternoon she had acute dilatation of the stomach, the stomach tube was passed and gallons of fluid came out with a large number of stones. These stones had got into the adherent duodenum through a perforation and were removed with the stomach tube. I may say she has lived happily ever afterward.

I have never been so foolish as to dispense with drainage in removal of the gall-bladder. I am more than glad Dr. Crile does favor drainage. I did try the transverse incision 30 times; then I went out to a hospital in the country and tried to show them how to do it, but the case was a very difficult one and I had to supplement it with a vertical incision. I may say I have not done it since, but I have operated for several very bad hernias following the transverse incision with division of the rectus muscle.

I want to emphasize what Dr. Gibbon says about removal of the gall-bladder. You may need it badly for drainage in case of obstructive jaundice from swollen head of the pancreas. It is difficult even with the abdomen open to tell the difference between pancreatitis and cancer. I have had patients get so much better after a cholecystoduodenostomy that for a time we were doubtful of the diagnosis. Some cases of supposed cancer have recovered after a cholecystogastrostomy.

Dr. Willy Meyer, New York:

In regard to diagnosis, I believe that the Meltzer-Lyon test is of no special aid in cases of cholecystitis, but it has great value in the therapy of diseases of the biliary tract. What I do believe is of real great value in diagnosing pathology of the latter is—besides a careful history and clinical analysis inclusive of radiology—the examination of the duodenal contents in the fasting condition of the patient and

then not trusting to one specimen withdrawn with the syringe, but to take a number of specimens inside of about two hours and have a man who understands it find out whether the bile is diseased. If the gall-bladder contains no stones I think it certainly ought to come out, because it may remain a focus of infection. And in that event, if for special reasons, ectomy cannot be done later on as a secondary interference, such a patient will become a chronic invalid.

One word regarding the peculiar experience we sometimes meet with after a straight operation for cholecystectomy: During the operation everything was going nicely, yet the patient dies under high fever and irremedial weakness of the heart within twenty-four to thirty-six hours. I had such a case recently. Fourteen hours after an uncomplicated cholecystectomy I received a hurry call stating the patient was in collapse. I knew there could not be a secondary hemorrhage. I found an acute edema of the lungs with an extremely weak and rapid pulse, also fever. After two hours' work the patient apparently responded, but in the end we could not save her. At postmortem we found all five lobes of the lungs in acutest inflammation, except half of the left upper lobe. I was inclined to attribute the condition to the effects of ether anesthesia though administered by an expert. But our pathologist, who also carefully examined the heart, diagnosed fibrosis of the bundle of His. He attributed the immediate cause of death to the heart. My opinion is that the liver, too, probably had something to do with the outcome.

A few days ago I listened to a paper by Dr. Charles G. Heyd, of New York, read before the American Gastro-Enterological Association at Atlantic City. In it he proved, on basis of investigations, that likely chronic hepatitis with acute insufficiency of the liver is responsible for these sudden deaths.

With reference to the combination of ulcer of the duodenum and cholecystitis, with and without stones, I have had 4 such cases within the last five years. If we find uniform, dense adhesions involving the stomach, duodenum, liver and gall-bladder, but no stones, it is wise to leave the gall-bladder alone and do a gastroenterostomy. Twice I ventured to do cholecystectomy under such circumstances, and in both instances lost the patient in consequence of an injury to the duodenum. In the presence of gallstones with symptoms of the latter supervening, a portion of the gall-bladder wall with its mucosa destroyed should be left attached to the region of the duodenal ulcer (two recoveries).

Dr. George E. Brewer, New York:

Dr. Whipple certainly has my sympathy in his cases of pancreatic asthenia. They are very striking and correspond with 2 cases that I had, in 1 of which I lost the patient. They were both characterized by profound asthenia which was out of the usual, and, as he says, like Addison's disease, with great muscular weakness and prostration. This came on five or six days after the operation, when apparently they were doing well. One was for acute pancreatitis and the other for pancreatic abscess. Finally, 1 case recovered. An enormous slough came out through the wound as the result of irrigation and the other case finally died from loss of strength. An autopsy showed that every bit of the pancreas was gone and the fat necrosis extended down almost to the sigmoid. At the same time there was very little infection. Patient never had a temperature above 100.° There were characteristic symptoms of pancreatic asthenia.

Dr. William D. Haggard, Nashville:

It seems that about the only question we are agreed upon is the very considerable danger of hemorrhage in jaundice cases. When we think of the case that Dr. Crile spoke of and the cases that were referred to by Dr. Deaver, which died in spite of everything that could be done as a preventive of hemorrhage, all cases of severe jaundice we think of as potentially liable to hemorrhage.

The contribution of Walters, of the Mayo Clinic, on the calcium chloride preparation is, however, very valuable. This method, as you know, is the introduction into the blood stream of 5 cc of a 10 per cent solution every day for three days. It only goes to show that it is not 100 per cent preventive of postoperative bleeding in these cases.

We remember very well when we did not operate on jaundice cases, and the rule was to put them off for a number of weeks, hoping that the stone would pass and the jaundice would clear up, or that the duct would compensate for the presence of the stone and allow the bile to pass and prevent this complication in many cases. Now we can anticipate bleeding in these cases before the jaundice ensues.

I want to call attention to one important point in connection with the use of calcium preparation, and that is to watch the blood-clotting time. You can feel reasonably secure that you will not have hemorrhage, but if you have to take a drain out at the end of a week, much to your surprise you may have a fatal hemorrhage, as we did in one case. If you will give the calcium again three days before

taking out the drain you will probably prevent the very great danger of secondary hemorrhage.

I think we all agree upon the importance of exposure, inability to see and to have ample space for necessary manipulation; that is the *bête noir* of the surgeon. Shall it be the Brewer or Kocher incision? No matter what incision is used it must be adequate, because most of the gall-bladder work necessitates an amply wide exposure.

Dr. L. L. McArthur, Chicago:

I am one who in the presence of an acute gangrenous cholecystitis am content to treat a gall-bladder lovingly—make an opening and expose it and wait until my patient is in a more favorable condition or until further surgery becomes necessary, and it is not often necessary. Many of these cases get well without a secondary operation.

I believe we should treat every case on its own merits. It is not reasonable and it is not logical to treat every such case by one system or method.

Dr. Crile (in closing):

I am sure that this has been one of the finest discussions I have ever heard.

First of all, I would like to say that the suture of Dr. Meade is a splendid one.

As to calcium, I have encountered hemorrhages even when the patients have been saturated with calcium both before and after the operation.

Dr. Porter has asked about intermittent drainage. In reply I may say that this is very much like the intermittent drainage in emptying the bladder. (Diagram on blackboard.) In this connection Dr. Mayo has mentioned a very interesting point. In making an anastomosis to the intestine or to the stomach there is a certain amount of pressure within those viscera which holds back a certain amount of bile, and this is very helpful.

The question which Dr. Porter asked, "What is internal respiration and what do you do to restore it?" is a very important one. Every bit of energy of the body is produced in cells, and to produce energy oxygen is required. Oxygen is supplied by the blood in circulation. Therefore, if the circulation is low and feeble, as it is in these cases, various methods must be used to maintain internal respiration. Such methods are blood transfusion, digitalis and large quantities of water. Large quantities of water, especially, combined with sleep and rest, we know will do more to maintain internal respiration than anything else.

Dr. MacLaren (in closing):

In the last few years I have been very much impressed with the confusion among writers in regard to acute gall-bladder disease, confounding the gangrenous and perforative type with the simple cystic gall-bladder, making one class only, under the head of acute cholecystitis, whereas the ordinary cystic gall-bladder is subacute. When you compare these two you have an entirely different problem, and Dr. Crile is eminently correct in his conclusions. My experience in the gangrenous and perforating type of gall-bladder has led me to believe that the least interference the better, and removal of the gall-bladder means too often the loss of the patient. I have lost several.

Dr. Balfour (in closing):

In answer to Dr. Freeman's question concerning the danger of hemorrhage following cautery excision, I may say we have successfully avoided postoperative hemorrhage by using the cautery at a low heat, closing the opening with deep interrupted sutures and placing a second row of sutures in the serosa.

In answer to Dr. Porter's question, some years ago we dealt with a number of gastric ulcers by local excision alone; many of the patients, however, developed symptoms later. They recovered promptly with gastroenterostomy, and we therefore abandoned local excision alone. It is possible, however, that by reason of recently acquired knowledge with regard to the proper management of patients with gastric ulcer, local excision alone may be carried out with better prospects of success.

Formerly patients were dismissed after operation for ulcer with the assurance that they were going to get well, and a large percentage did get well and remained well. Now, the surgeon recognizes the importance of doing something more, that is, advising the eradication of any foci of infection, and the regulation of habits of living, especially diet, careful regulation of the bowels and avoidance of prolonged mental and physical stress. It may be that results will be satisfactory if certain small ulcers are excised and such a régime is followed; but in order to attain the best results, it is probable that adequate drainage by a well-performed gastroenterostomy must be added to the local excision.

Dr. Whipple (in closing):

In reply to Dr. Graham's question, may I briefly read over the pathological findings in the 12 cases in which carcinoma was not found?

(The pathological findings in the 12 cases in Table III were read.)

SURGICAL EXPERIENCES WITH EIGHT CASES OF TUMOR OF THE THORACIC WALL, PLEURA AND MEDIASTINUM

By GEORGE J. HEUER, M.D.
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Among a goodly number of patients with thoracic conditions which we have seen in the past few years have been 8 who presented tumors of the thoracic wall, pleura or mediastinum which seemed to be operable. They were therefore subjected to operation and an attempt made—although not always successful—to remove the new growths. They form, especially from the viewpoint of the nature of the tumors, an interesting small group, and I present our experiences with them with the hope that a discussion may promote a better understanding of the pathology of intrathoracic tumors and help us to overcome some of the difficulties we have encountered.

Case I.—The first case is one of intrathoracic *calcified cyst* arising from the anterior mediastinum and projecting into the right thoracic cavity. The case was reported in the *Review of Tuberculosis*, May, 1917, No. 3, vol. i, and I refer to it again in order to report upon the end-result.

The patient was a colored man, aged fifty-three years, who entered the Johns Hopkins Hospital October 31, 1916, complaining of pain in his right chest. The onset of his illness was stated to have occurred three weeks before, when, after lifting a heavy bag of cement, he had a sharp pain in his right side accompanied by coughing. He left his work and on the advice of his physician

FIG. 1.—*X*-ray of Case I, showing shadow of calcified cyst in right thoracic cavity.

went to bed and remained there until his admission. Pain and paroxysms of coughing with abundant yellowish sputum were frequent. There was no hemoptysis.

On physical examination the right chest was flattened and there was limitation of respiratory movements. There was dulness below the 3d rib in front and flatness below the 6th rib. Over the back there was flatness below the 6th thoracic spine. A provisional diagnosis of pleurisy with effusion over the right base was made. An attempt at aspiration, however, was unsuccessful, the exploring needle meeting an unyielding resistance. *X*-ray plates (Figs. 1 and 2) showed a well-defined shadow within

FIG. 2.—*X*-ray of Case I, in the erect posture, showing the fluid level.

the thorax suggesting a calcified cyst. A positive diagnosis was not made. Sputum examinations repeatedly made gave no information of value. Dermoid cyst, echinococcus cyst, encapsulated empyema and neoplasm were the possibilities suggested.

Operation was performed November 8, 1916. A long incision, encircling the right half of the thorax, was made and practically the entire 9th rib removed. The parietal pleura was stripped from the thoracic wall over a wide area to give us a better opportunity for exploration. Directly under the mobilized pleura

FIG. 3.—Photograph of calcified cyst. The defect in its wall represents the area over which it was attached to the pericardium and great vessels.

was felt a very hard mass of large size. An incision was made through the pleura and the freeing of what was evidently a calcified mass begun. It was a slow, difficult procedure, due to the adhesions between the mass and the pleura, lung, diaphragm and mediastinum. Eventually, however, it was freed down to an area about 6 x 4 cm. in diameter, where the mass was densely adherent to the pericardium and great vessels. Here the calcified shell was replaced by fibrous tissue, and it was during the separation of this portion of the mass that some of its contents —a thin, yellowish, purulent material—escaped. It was thought advisable, therefore, after removal of the mass, to drain the thoracic cavity.

Postoperative convalescence was uneventful. The wound healed nicely. The lung promptly expanded to fill the large cavity left after the removal of the mass. The patient was discharged with his wound healed.

Comments. From an operative standpoint there was nothing difficult about this case, although the enucleation of the mass, and especially its separation from the pericardium and great vessels, was tedious. Simple ether anesthesia without any pressure apparatus was used, and throughout there were no respiratory difficulties. The exposure through a simple long incision was adequate even for the removal of so large a mass. The diagnosis remains in doubt. The specimen consists of a calcified shell as large as an infant's head without a lining membrane (Fig. 3). The most careful examination of the contents of this shell gave us no clue as to its nature. The patient remained in good health until 1921, five years after operation, when he entered the hospital on the medical service with myocardial insufficiency. Physical and *x*-ray examination at that time showed some retraction of the right chest, slight thickening of the pleura and dilatation of the heart and aorta. At the present time (August 20, 1923) he reports that he is in good health.

Case II.—The second case is one of recurrent *osteochondrosarcoma* of the 10th rib involving the pleura.

A girl, aged fourteen years, was first admitted to the Johns Hopkins Hospital April 21, 1919, complaining of a tumor over the 10th rib in the posterior axillary line. The tumor was about 6 x 3 cm. in diameter, was firmly attached to the rib, was of stony hardness and slightly tender. A diagnosis of sarcoma of the rib was made, and on April 29 Dr. M. R. Reid resected a portion of the 10th rib with the tumor mass. The posterior periosteum was removed. The pleura was not interfered with. Examination of the tumor in Bloodgood's laboratory showed an osteochondrosarcoma. The patient left the hospital with her wound completely healed.

Two years later the patient returned to the hospital with a

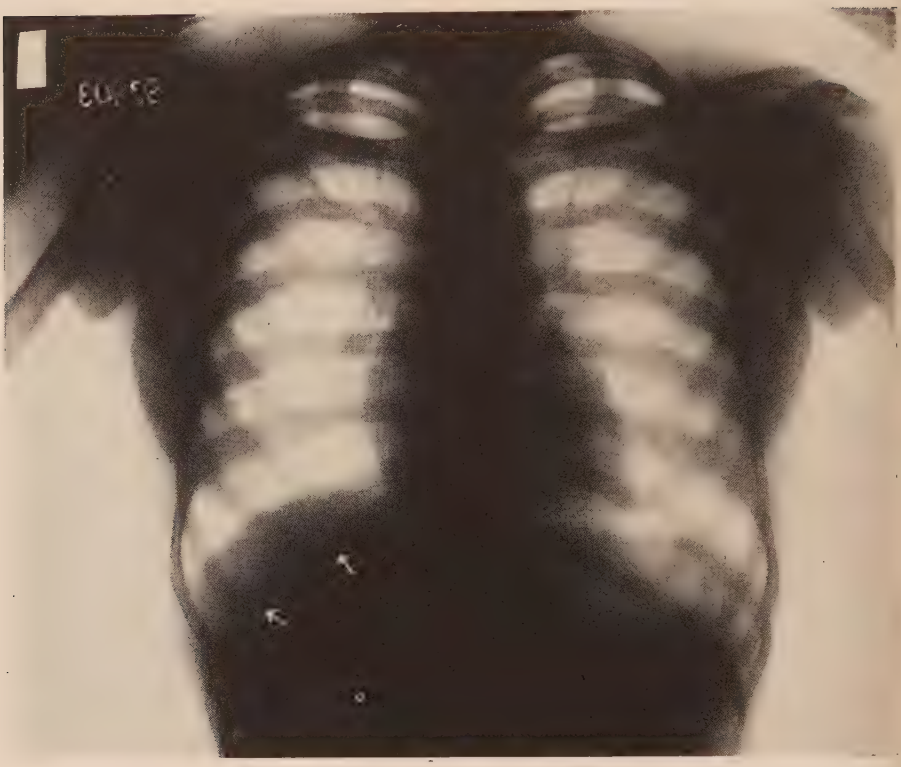

FIG. 4.—*X*-ray of Case II. The arrows point to the area of destruction in the rib.

recurrent tumor attached to the proximal end of the resected 10th rib. The mass was about as large as on her previous admission. The skin over the tumor was freely movable. *X*-rays of the thorax (Fig. 4) showed marked destruction of the rib over a distance of 6 cm. No involvement of the other ribs was discovered.

The second operation was performed June 27, 1921. The skin was widely freed over the tumor. The 9th and 10th ribs were divided well behind and in front of the tumor. The intercostal muscles and pleura were divided at the same level and a large rectangular mass of tissue, including the tumor, por-

tions of the 9th and 10th ribs, intercostal muscles and pleura, was removed.

This left a large defect in the thoracic wall about 15 cm. long and in width corresponding to two ribs and three intercostal spaces. With the production of such a large opening in the thoracic wall there occurred a definite respiratory upset with cyanosis and tachycardia. The lung was quickly drawn into the opening and held there until we had decided what form of plastic procedure to use to close the opening. The diaphragm seemed the only available structure, and therefore it was drawn up to the opening and sutured to its margins. The skin was closed tightly.

Postoperative convalescence was uneventful. The lung quickly expanded. The patient was discharged apparently well. At the present time (August, 1923), two years after operation, she is without evident recurrence.

Comments. The interesting feature in this case was the use of the diaphragm to close a large defect in the thoracic wall. The opening was too low to make satisfactory use of the latissimus dorsi muscle, but not too high to make use of the diaphragm. There was no evidence at the time of the patient's discharge that the diaphragm had pulled away from its place of attachment. The respiratory upset, which occurred with simple ether anesthesia, was not serious, yet was sufficiently disturbing to make it seem advisable to have at hand some form of pressure apparatus in subsequent operations.

Case III.—The third case is one of intrathoracic, extrapleural *xanthoma* or *xanthosarcoma*, the first xanthoma, so far as I can learn from the literature, to be reported in this locality.

The patient, a physician, aged twenty-nine years, had for fourteen years pain of a cramp-like nature in the right lower quadrant. The pain was not associated with fever or nausea; nevertheless, in 1911, on the advice of his physician, he had his appendix removed. The appendix was normal and its removal failed to relieve his pain. During his service with the army in

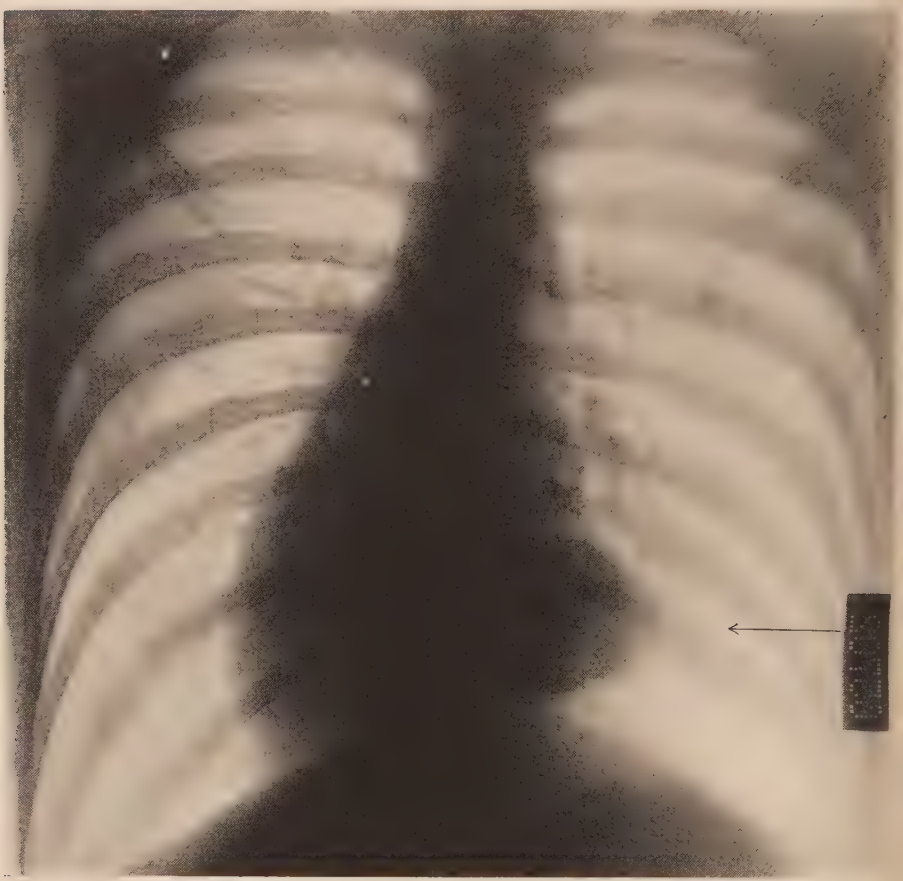

FIG. 5.—*X*-ray of Case III. Anteroposterior view, showing the shadow of a tumor to the right of the cardiac shadow.

France the pain became more severe and he was repeatedly examined. A relaxed inguinal ring with an impulse was noted and a hernia operation was suggested but refused. Cystoscopic examination, catheterization of the ureters and thorium injections of the renal pelvis with *x*-ray examinations failed to discover any abnormality. *X*-rays of the gastrointestinal tract were negative. He continued to have pain in his lower right quadrant, but in

FIG. 6.—*X*-ray of Case III. Lateral view, showing the shadow of the tumor against the spine.

addition began to have severe pain in his back which was called lumbago. In November, 1918, he had influenza and an *x*-ray of his chest showed a mass behind and to the right of his heart shadow. Subsequent *x*-rays confirmed this finding. He was explored with a needle, but the exploration was negative. On his return from France he was given radium treatment in Baltimore, but without benefit. His physical examination was negative except for the tumor shown in the *x*-rays (Figs. 5 and 6).

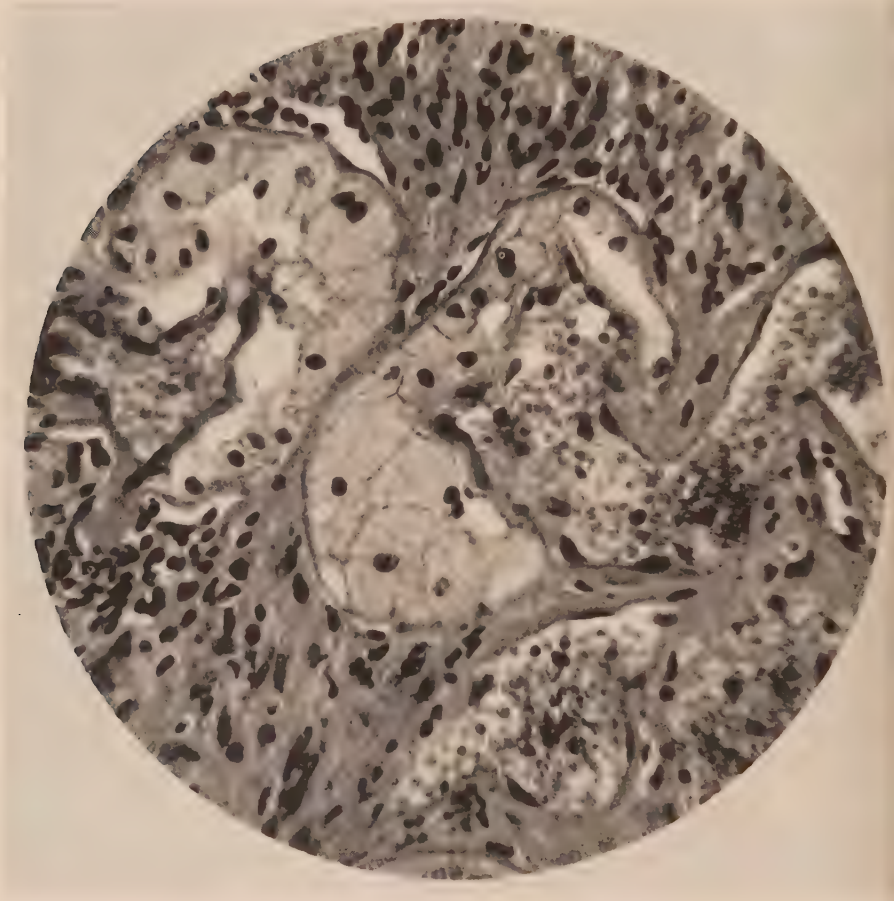

FIG. 8.—Case III. Microscopic section of xanthoma, showing groups of "foam" cells.

Operation was performed October 15, 1919. A long incision was made over and parallel with the 9th rib. The proximal six inches of this rib were resected and the parietal pleura stripped from the thoracic wall over a wide area. Without opening the pleural cavity the tumor was exposed. It was larger than a hen's egg, lay against the bodies of the vertebræ and seemed attached

FIG. 7.—Case III. Painting by Mr. M. Brödel, of the cut surface of the tumor (Xanthoma), showing areas of yellow pigmentation.

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to the 10th rib. The pleura was readily separated from it. Having freed the tumor down to its apparent attachment to the ribs, portions of the 10th and 11th were resected and removed with the attached tumor. The operation was completed without at any time opening the pleura. The wound was closed without drainage.

Postoperative convalescence was uneventful with the exception that the extrapleural space filled with fluid which, however, subsequently disappeared. The wound healed *per primum*. The patient is perfectly well and free from pain four years after operation.

Comments. The most interesting feature of this case is the nature of the tumor (Figs. 7 and 8). It is a typical xanthoma and the first, I think, which has been reported within the bony thorax. Its origin is uncertain. Its only point of attachment was apparently the 10th rib, but examination after the removal of the tumor showed that this attachment was not to the bony rib and not precisely to the periosteum. At least the attachment was not such that the tumor could be said to arise from the periosteum.

A second interesting feature of this case was the extrapleural approach and the removal of the tumor without opening the pleural cavity. It has been found in approaching thoracic lesions that stripping the parietal pleura has a number of advantages. It permits through the resection of a single rib a wide exploration of and an approach to lesions before the pleura is opened. It enables one to determine where, if any, adhesions between lung and pleura exist. In all the cases reported in this series it has proven to be a useful procedure.

Case IV.—The fourth case is one of *chondromyxoma* or *benign cyst* occupying the upper half of the right thoracic cavity and arising presumably from the costovertebral articulations of the 4th and 5th ribs.

The patient, a man, aged forty-seven years, was admitted to the Johns Hopkins Hospital November 13, 1920, complaining

of pain in the right upper thorax and cough with bloody sputum. Six years before admission he began to have pain in his right upper thorax and under his right scapula. About the same time he developed a cough which was thought to be due to pleurisy. There followed attacks of fever, increased pain, cough and hoarseness which put him to bed three or four times a year for periods of three or four weeks. A year before admission he had during one of these attacks a profuse hemorrhage from his lungs and was seriously ill with a high fever and delirium. After convalescing from this attack he was sent to Saranac, where he remained six months and where repeated sputum examinations failed to show any tubercle bacilli. A needle was inserted into his chest and blood obtained. During the year before admission he had become increasingly more dyspneic and had lost weight.

Examination showed immobility of the right upper thorax, dulness on percussion extending down to the 2d rib in front and the fourth spine behind, and diminution in the breath sounds. *X*-ray plates of the chest (Fig. 9) showed a large mass occupying the upper half of the right thorax. A diagnosis of a benign new growth was made with the supposition that it was a dermoid cyst.

Operation was performed November 18, 1920. Under simple ether anesthesia an incision was made anteriorly over the 4th rib from the right sternal margin to the anterior axillary line. The fibers of the pectoralis major were separated and about six inches of the 4th rib resected. The parietal pleura was stripped from the thoracic wall over a fairly wide area. Beneath it the lung was seen moving freely, and on palpation through the thin layer of lung tissue there could be felt a large, firm mass. The parietal pleura was therefore incised and the thin film of lung tissue freed from the presenting surface of the tumor. The lung was but slightly adherent to the mass and could be readily freed from its surface. After about half the mass was freed it presented itself as a spherical tumor as large as a grapefruit, filling almost the entire upper one-third of the right thoracic cavity, definitely fluctuant on palpation and with a grayish-yellow wall

FIG. 9.—*X*-ray of Case IV, showing a dense, circumscribed shadow in the upper half of the right thoracic cavity.

in part calcified. On continuing the enucleation of the mass the lung was found to be adherent in one area, and here the wall of the mass was ruptured. There escaped a gelatinous myxomatous material, and thinking that the removal of this might help us in

our further efforts, we deliberately incised the wall of the mass and removed large quantities of this sticky material. Inserting our hand within the mass we found the posterior half of it filled with arborescent masses of calcified tissue, which converged to a hard, bony mass fixed to the posterior thoracic wall. Returning at this point to the enucleation of the now collapsed wall of the tumor we freed it posteriorly to a point where it converged into the bony mass just described. This mass was most firmly united to what was taken to be the 4th and 5th ribs at their junction with the vertebral column. It was freed from its attachment with rongeurs and the entire wall of the tumor removed.

There was practically no bleeding throughout the procedure, and there was not at any time any respiratory disturbance or cyanosis. The wound was closed without drainage. The patient was considerably shocked at the end of the operation and his pulse was about 150. His color, however, was good and we felt no particular anxiety about his condition. Suddenly, about an hour after operation, he gave a few gasping respirations and died. An autopsy was not obtained.

Comments. It was indeed hard to lose the patient after the removal of what was evidently a benign lesion. The nature of this tumor to my mind is in doubt. Bloodgood examining various portions of its wall concluded that it was a benign cyst resulting from a hemorrhage due to tuberculosis, with the organization of a hematoma and ossification of its wall. Against this diagnosis was the clinical appearance of the tumor at operation and the fact that it was entirely extrapulmonary and I believe extrapleural. No connection with the lung could be determined at operation nor the source of the previous hemoptysis. The tumor had no connection with the mediastinum and therefore a dermoid can in all probability be ruled out. Our own opinion, based largely upon the findings at operation, is that the mass was a myxochondroma arising from the posterior thoracic wall.

Case V.—This is one of *pleural endothelioma*, possibly of *sarcoma*, arising in the upper right thorax.

The patient, a man, aged thirty-three years, was admitted to the hospital February 16, 1920, complaining of pain in his right chest. Five years previously he began to have thoracic pain localized at first in his right axilla, later becoming more general. This had gradually become more severe. Pain was the only symptom complained of until a year before admission, when he developed a cough which has persisted. It was unaccompanied by sputum or hemoptysis. Recently there had been some dyspnea even on the slightest exertion. In the five years of his discomfort he had consulted numerous physicians, had many *x*-rays taken, all of which showed an intrathoracic tumor, and had tried a course of radium treatments in Baltimore without benefit.

Examination showed a well-nourished man with moderate dyspnea, with limitation of movement of the upper right thorax and with dulness over the upper right chest in front and behind. To the right of the sixth dorsal spine over an area 3 cm. in diameter could be heard a fairly loud systolic murmur which was not transmitted from the cardiac area. *X*-ray examination (Fig. 10) showed a large intrathoracic mass which did not pulsate on fluoroscopic examination, and which was diagnosed a cyst or a sarcoma.

Operation was performed February 21, 1920, under simple ether anesthesia. A T-shaped incision was made over the right thorax anteriorly, the horizontal leg extending from the sternal margin laterally to the axilla over and parallel with the 3d rib, the vertical leg paralleling the right sternal margin. The 3d rib was resected; the costal cartilages of the 2d and 4th ribs were divided at their junction with the sternum, permitting wide retraction with a rib spreader. The parietal pleura was stripped from the thoracic wall, this procedure allowing a still greater field for exploration. No adhesions between the lung and parietal pleura were seen. The pleura was therefore freely incised at a point of election and an attempt made to free the presenting portion of the upper lobe of the lung from the underlying tumor. Unlike the preceding case, this was an extremely difficult matter,

FIG. 10.—*X*-ray of Case V, showing a circumscribed shadow in upper half of the right thoracic cavity.

due to adhesions between lung and tumor and to numerous thin-walled vessels, bleeding from which was quite profuse. Finally, however, after considerable effort and some loss of blood, about half of the tumor was freed. It was the size of a grapefruit, deep red, succulent, pulsating, almost fluctuant, and evidently very vascular. It was immovably fixed apparently to the mediastinal structures and the posterior wall of the thoracic cavity. A large aspirating needle was introduced into the tumor and pure blood, which, under the microscope, showed no abnormal cells, was withdrawn.

In view of the size, vascularity and fixation of the tumor any attempt to remove it was abandoned. The wound was carefully closed without drainage. The patient made a prompt recovery from the operation, but the pain naturally continued. Thinking that a thoracic decompression might aid both the pain and dyspnea, the patient was again subjected to operation.

On March 13, about three weeks after the first operation, a long incision was made across the back over the course of the 8th rib. The lower angle of the scapula was reflected upward. Portions of the 6th, 7th and 8th ribs were resected, totaling 46 cm. The intercostal muscles of the 6th and 7th interspaces were excised. Immediately under the operative field was the tumor, which was under such pressure that when the ribs were resected the mass actually bulged through the operative opening. The pleura was incised and an attempt again made to determine the origin of the tumor. We could merely say that the mass was firmly fixed to the posterior thoracic wall and to the mediastinum. The mass was again aspirated and the material sent to the laboratory. The wound was closed without drainage.

The patient again made an uneventful recovery. The wound healed *per primum*. He was discharged from the hospital three weeks after operation, with marked improvement in his pain and dyspnea. Some time after returning home, however, his pain and dyspnea returned. A newspaper clipping received four months after operation stated that he had died.

Comments. The interesting features in this case are, first, the size and extraordinary vascularity of the tumor. As recorded in the history a bruit could be heard over it and at operation it definitely pulsated. The examination of the aspirated contents removed at the second operation showed large masses of tumor cells, the character of which suggested to Bloodgood an endothelioma or a sarcoma. MacCallum confirmed the diagnosis of endothelioma. A second feature was the satisfactory exposure of a large tumor by an anterior approach, first used, I believe, by Tuffier and Le Fort. By the resection of a single rib combined with the division of the adjacent costal cartilages an

exposure was obtained which would have been adequate for the removal of this tumor. A third feature was the inadequacy of a decompression operation to relieve for any period the pain and dyspnea. From the appearances at operation, *i. e.*, the pressure exerted by the tumor upon the thoracic wall and necessarily upon the mediastinum and the herniation of the mass through the operative defect as occurs in cranial surgery, I had anticipated that this was an ideal case for a decompressive thoracotomy. Such, however, was not the case.

Case VI.—This is a second case diagnosed as a *pleural endothelioma*.

The patient, a white man, aged forty-five years, entered the Johns Hopkins Hospital December 7, 1921, complaining of a painful lump in his right side. He dated his illness from an attack of influenza three years previous to his admission. During this illness he complained of soreness under the ribs of his right side, which continued and increased after the attack of influenza had subsided. In August, 1921, he first noticed a small, painful nodule upon one of his ribs which gradually increased in size until at the time of his admission it measured about 6 cm. in diameter. The pain, which at first was local, later radiated to the pit of the stomach and around to the back. It had become so severe that the man was unable to work and could not sleep.

Examination showed a fairly well-developed although anemic man. Near the right costal margin, inside the mammillary line, was a non-pulsating, hard tumor mass measuring 6 x 5 x $\frac{3}{4}$ cm. and apparently firmly attached to the 7th and 8th ribs. The skin over the tumor was freely movable. The *x*-ray of this region was quite negative. Examination otherwise showed old, healed tuberculosis of both spaces. A diagnosis of probable sarcoma of the ribs was made.

Operation was performed December 14, 1921, by Dr. Emil Holman, then resident surgeon at the hospital. A long incision encircling the thorax was made parallel with the 7th and 8th ribs. The superficial muscles overlying the tumor were divided.

The deeper muscles were attached to the growth and were subsequently removed with it. On closer examination the mass appeared to penetrate the thoracic wall between the 7th and 8th ribs not to arise from them, and this observation was later confirmed. The 7th and 8th costal cartilages were divided at their junction with the sternum. An attempt was made to strip the parietal pleura, but this was unsuccessful, and the pleural cavity was widely opened. There was a momentary respiratory upset and anesthesia was continued with a gas-oxygen apparatus using positive pressure. On opening the pleural cavity the greater part of the tumor was found to be intrathoracic. It involved both leaves of the pleura in the costophrenic sulcus and was firmly adherent to the diaphragm. The bloc removal of the tumor required the wide resection of the 7th and 8th ribs, the resection of a fairly large area of the diaphragm and of the diaphragmatic and costal pleuræ. The diaphragmatic reflection of the peritoneum was exposed but not opened. The closure of the defect in the diaphragm was difficult, and as a result of the resection of this structure it could not be used in the plastic closure of the large opening in the thoracic wall, as in a previous case. Closure of the thoracic opening, however, was accomplished by use of the external oblique muscle, the rectus sheath and the anterior portion of the latissimus dorsi muscle.

Postoperative convalescence was uneventful excepting for a mild respiratory infection. The wound healed *per primum*. The patient was discharged from the hospital three weeks after operation, quite relieved of his pain and in excellent physical condition. A letter from his family states that he died ten months after operation.

The tumor on removal was about the size of a lemon. The pleura over it was attached and thickened. From the gross examination it could not definitely be said, in my opinion, that it arose from the pleura. Yet if it did not its origin is as problematical as is that of the xanthoma previously recorded. The microscopic diagnosis made in Bloodgood's laboratory was endothelioma of the pleura.

Comment. The only unusual feature of this case from an operative standpoint was the necessity of resecting the diaphragm. The closure of the defect proved to be unexpectedly difficult. Whether closure upon the right side is necessary is a question upon which we have very little information. Upon the left side, however, one would be unwise, I think, to leave a defect of any size even with an intact peritoneum.

Case VII.—This is a third case diagnosed as *pleural endothelioma.*

The patient, a white girl, aged seventeen years, was admitted to the Johns Hopkins Hospital October 21, 1921, complaining of a swelling upon her back. About eight months before admission she noticed a small, painless lump just below the angle of the left scapula. Her family physician said it was a cyst and at first little attention was paid to it. The mass, however, increased rather rapidly in size and five months after its appearance became painful, the pain radiating up to the left side of the neck and around the left side. In the two months before her admission this pain had become so severe as to quite incapacitate her.

Examination showed a fairly well-nourished and well-developed girl in whom the only abnormality found, with the exception of the tumor to be described, was a well-compensated mitral insufficiency. Just below the inferior angle of the left scapula was a swelling as large as a hen's egg, the skin over which was normal in appearance and freely movable. On palpation the mass was tense, gave the impression of fluctuation and pulsated with a definitely expansile pulsation. Over it could be heard a loud, systolic bruit. It seemed to be attached to the 9th and 10th ribs. *X*-ray (Fig. 11) showed a tumor mass and a partial destruction of the 9th and 10th ribs close to the spine. Baetjer, from the *x*-ray plate alone, suggested an acute infectious process, Futcher made a diagnosis of aneurysm of the descending thoracic aorta and Baer thought it was a cold abscess with transmitted pulsation. A younger member of the surgical staff aspirated the swelling and obtained what appeared to be pure blood, but which

FIG. 11.—*X*-ray of Case VII, showing the tumor opposite the ninth and tenth thoracic vertebræ. (Picture inverted.)

when examined by Guthrie showed masses of tumor cells. A final diagnosis of intrathoracic tumor either endothelioma or sarcoma was made.

Operation was performed October 26, 1921, under simple ether anesthesia. A large skin flap with its pedicle over the spine was reflected. The erector spinæ muscles over the mass were displaced mesially and laterally, a procedure which exposed the tumor still covered, however, with muscle tissue. The 9th and 10th ribs were exposed and divided well in front of the tumor and an attempt made to strip the parietal pleura. On approach-

ing the mass the pleura was found adherent to it, therefore the pleura was freely opened and the tumor examined. It was the size of a lemon, was rather fixed to the ribs and vertebræ and had no connection with the aorta. The pleura over it was thickened and presented plaques and masses of tumor on its inner surface. The operation then resolved itself into the removal en bloc of the 9th and 10th ribs back to the spine, the tumor and the pleura. The removal of this bloc of tissue left a very large defect in the thoracic wall, which, however, could readily be air-tightly closed by a muscle plastic. The wound was closed without drainage. At no time was there any respiratory upset.

Postoperative convalescence in this case was complicated by the development of a hemolytic streptococcus empyema. At the time there was in the hospital ward with the patient a considerable number of patients with influenza, and the patient herself developed a respiratory infection. Whether then the infection was introduced from without or from within is problematical. As soon as the diagnosis was made aspiration drainage at a point below the operative wound was instituted and Dakinization of the cavity begun. Fortunately, in spite of the intrapleural infection, the large operative wound healed *per primum*. She was discharged two and a half months after operation with her empyema completely cured. A letter dated August 30, 1923, two years after operation, states that she is in good health but has some pain in her side.

Comments. An interesting feature in this case was the establishment of a positive diagnosis by the aspiration before operation of tumor cells. The method of diagnosis was, in Baltimore at least, first largely used by Dr. C. G. Guthrie, and has proven very helpful in doubtful cases. The postoperative empyema which developed was most unfortunate, but happily did not interfere with a satisfactory result. It serves to illustrate what we so thoroughly learned in war wounds, *i. e.*, that in case of a pleural infection following an intrathoracic operation it is unwise to drain through the operative wound, for to do so means in most instances an infection of the wound with the development

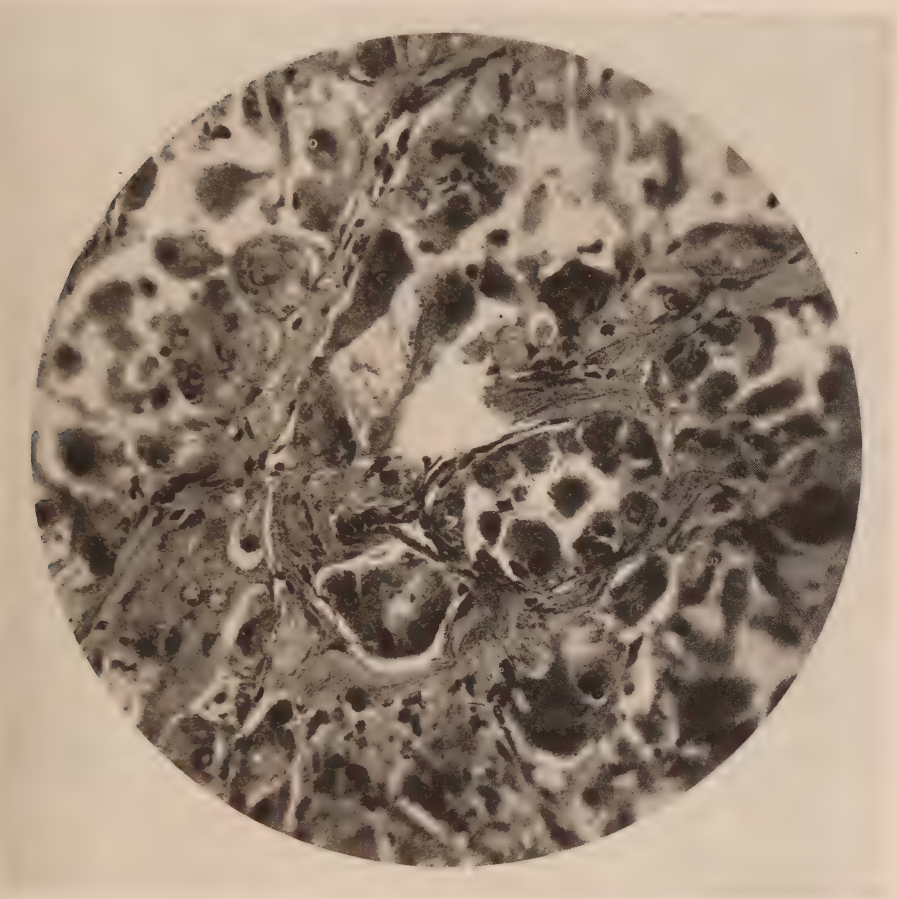

FIG. 12.—Microscopic section of the tumor removed from Case VII.

of an open pneumothorax. A microscopic section of the tumor is shown in Fig. 12.

CASE VIII.—This is a case diagnosed by many before operation as a mediastinal tumor which subsequently proved to be a *retropleural aneurysm of the descending thoracic aorta.*

The patient, a young man, aged twenty-nine years, was

admitted to the Cincinnati General Hospital April 18, 1923, complaining of pain in his chest. He had been thoroughly studied in Baltimore and through the kindness of medical friends there had been sent to Cincinnati for observation and treatment. The history relates that while with the army in France, early in 1919, he began to have pain in the back which at first was localized under the right scapula. The pain came on spontaneously without known cause. It gradually increased in severity, radiated around to the front of the chest and was associated with hyperesthesia of the skin about the right costal margin. Since its onset the pain has never disappeared and has gradually worn down the patient's resistance, so that recently he has been quite incapacitated. There has been some dyspnea on exertion. He has never had cough or expectoration. Since 1919 he has been, with the exception of short intervals, an inmate of hospitals in France and this country. He has repeatedly been examined, numerous *x*-rays and fluoroscopic examinations have been made and his Wassermann reaction has been repeatedly tested. All examinations have shown an area of dulness over the back, extending from the 5th to the 9th dorsal spines and 13 cm. to the right and 4 cm. to the left of the posterior median line. All *x*-rays have shown a large mass in the posterior mediastinum extending to either side of the midline. No observer has, so far as I can gather, seen this mass pulsate on fluoroscopic examination. One roentgenologist at Fort McHenry, Baltimore, suggested the diagnosis of aneurysm, all other observers had made a diagnosis of mediastinal tumor. One Wassermann reaction was weakly positive, many others were negative. He has received an excessive amount of antiluetic treatment without avail, nor have deep *x*-ray therapy or radium treatments had any influence upon his symptoms.

Our own examination seemed to confirm those previously made. The same area of dulness over the back was found and stereoscopic *x*-ray plates (Figs. 13 and 14) showed a large mass rather centrally placed in the posterior mediastinum. Examined fluoroscopically the mass lay behind the base of the heart and

FIG. 13.—*X*-ray of Case VIII, showing the large centrally placed shadow in the thorax.

did not pulsate. The ascending arch of the aorta could be seen displaced upward and to the right, and could be clearly differentiated from the mass by its pulsation. On swallowing bismuth the esophagus could be seen curving forward in front of the mass. In view of our previous experiences we also made a diagnosis of tumor probably extrapleural and arising from the ribs or spine.

Operation was performed May 7, 1923, with intratracheal insufflation anesthesia. A long, lateral incision was made over the right fourth rib extending from the posterior axillary line to the sternum. The 4th and 5th ribs were resected. Beginning posteriorly the parietal pleura was widely mobilized until the

FIG. 14.—*X*-ray of Case VIII. Lateral view, showing outline of tumor behind the cardiac area.

right lateral border of the mass was exposed. The mass was definitely extrapleural for the parietal pleura could be freed from its anterior wall. But the pleura was adherent and therefore was incised and the pleural cavity widely opened. The mass was of large size and lay behind the base of the heart, the decending arch of the aorta and the esophagus.

It was unconnected with any structures in front but posteriorly was firmly fixed to the posterior thoracic wall and spine. Its presenting surface was smooth and grayish-yellow in color, not unlike the case of chondromyxoma previously described. The mass as a whole pulsated strongly. Fearing that after all the lesion was an aneurysm, a considerable amount of time was expended in discovering the possible origin of the mass, and as a

result of our efforts, we concluded that the mass fused with or blended with the descending aorta behind the base of the heart. My assistants, however, were not satisfied, and therefore we deliberately incised the mass, extruded some clots for examination and resutured the incision. There was no hemorrhage during the procedure. The examination of the clots failed to show anything but blood cells.

Not being prepared by our exposure to treat the aneurysm at its source the operation was abandoned. The pleura was resutured and the wound closed without drainage. The postoperative convalescence was complicated by the formation of a bloody effusion which, however, disappeared after one aspiration. The wound healed *per primum*. For twelve days the patient remained in excellent condition, then suddenly after great pain he became pallid and there appeared a pulsating mass under his operative scar. He died May 19.

Autopsy. Retropleural aneurysm of the descending thoracic aorta. Rupture of the aneurysm along its right lateral border. Massive right hemothorax. The communication between the aorta and the aneursymal sac was in the posterior wall of the aorta directly in the midline and measured 3 cm. in diameter. The sac extended retropleurally to either side of the spine but farther to the right than to the left. Its posterior wall was formed by the vertebræ which were markedly eroded and by the adjacent posterior thoracic wall. The incision made at operation into the anterior wall of the sac had healed. Rupture of the sac had occurred about 4 cm. from it at the junction of the anterior wall of the sac with the posterior thoracic wall.

Comments. The case is included in this series because it demonstrates the difficulties in the differential diagnosis between some thoracic aneurysms and intrathoracic tumors. Two other cases in this series—both with expansile pulsation—were diagnosed wrongly as aneurysms. This case pronounced by many competent observers a solid tumor proved to be an aneurysm. It is well known, of course, that aneurysm of the thoracic aorta may not show visible pulsation under the fluoroscope. But in

this case the age of the patient, the duration of the symptoms and especially the position of the mass were all against the diagnosis of aneurysm.

SUMMARY. Of the 8 cases in this series 6 recovered from operation, 2 died soon after operation: 1 with symptoms of pulmonary embolism and 1 from the rupture of an aneurysm. Of the 6 patients who recovered 2 are living and well five or more years after operation and 2 are living and apparently well two years after operation. One patient died four months after operation unimproved by a decompressive thoracectomy, and 1 patient died ten months after operation from a recurrence of his disease. The lesions form a miscellaneous group and the diagnosis in a number of cases remains in doubt. The nature of one, a calcified intrathoracic cyst, remains problematic, as does the large tumor called by Bloodgood a hemorrhagic cyst, by me, a chondromyxoma. The sarcoma of the ribs, the xanthoma and the aneurysm are sufficiently well established, but I am not so clear regarding the 3 instances of circumscribed encapsulated tumors called by our pathologists endotheliomata of the pleura. These tumors were first described by E. Wagner, later by Schulz, as extensive diffuse tumor formations giving rise to a markedly thickened pleura and associated with a bloody effusion. I have seen 2 such cases: 1 in Baltimore and 1 in Cincinnati. In both a thoracostomy had been done in the hope that drainage of the bloody effusion would relieve the pain and dyspnea. In one the *x*-ray showed the entire pleura about three inches in thickness and in the other it showed a solid shadow due to the almost complete filling of the entire half of the thorax with tumor tissue. In none of the works on pathology which I have been able to consult do I find described the circumscribed encapsulated endotheliomata of the pleura such as we have had. Aschoff, however, in his classification of endotheliomata into hemangioendothelioma, lymphangioendotheliomata, and perithelioma states that the lymphangioendotheliomata may occur as circumscribed tumors, and it is possible that such tumors of the pleura may be analogous to those of the dura and pia-arachnoid.

DISCUSSION

Dr. Howard Lilienthal, New York:

Dr. Heuer has shown us that many of these tumors of the chest wall and mediastinum are of doubtful pathology and has shown us one unique specimen. The only point is whether we are dealing with a benign or a malignant condition. I think when tumors have reached a size such as to make life intolerable for the patient they should be treated the same as if they were malignant, whether they are so or not.

I would like to add one pathological report of interest, and that is of a ganglioneuroma the size of a lawn-tennis ball which I removed from the right superior mediastinum in a child, eight years of age. I believe this is the only case on record of its kind. After removal the child showed in the eye of the same side the characteristic enophthalmos and contraction of the pupil which follows interference with the cervical sympathetic. These signs seem to be gradually disappearing.

THE PROGNOSIS AND TREATMENT OF FRACTURES OF THE LEG AND ANKLE

(END-RESULTS IN 100 PATIENTS)

By ASTLEY P. C. ASHHURST, M.D.

AND

EDWARD T. CROSSAN, M.D.

(By Invitation)

PHILADELPHIA, PA.

Prognosis is defined as the art of foretelling the course and termination of a disease. In no case can one give any accurate prognosis without knowing from his own experience or from that of others what has been the course and termination of similar cases. Hence arises the importance of studying end-results as well as the clinical course of the disease.

It was shown in the report on fractures of the tibia and fibula presented to this Association in 1921,[1] that among a total of 914 such fractures analyzed, good function was secured in 71 per cent of cases, moderate function in 20 per cent and bad function in 9 per cent (see Table IX herewith); that the average period of disability in *simple fractures* was four months for ankle fractures and four and seven-tenths months for fractures of the leg proper; while in *compound fractures* the average period of disability was five and seven-tenths months for the ankle fractures and seven months for those of the leg (see Table XI herewith). It was further noted that these investigations merely pointed the way for further improvement in our means of treat-

[1] Ashhurst: Trans. Amer. Surg. Assn., 1921, xxxiv, 528.

ing fractures of the tibia and fibula, and that no surgeon having such fractures under his care should rest satisfied until he could publish a series of end-results which in the aggregate would be superior to those therewith reported, since these were merely the average.

It was with this in mind that the present investigation was undertaken. We have compiled accurate records of the end-results in 100 out of 152 fractures of the leg and ankle treated in recent years in the Service to which we are attached at the Episcopal Hospital, Philadelphia. With very few exceptions the patients have been personally examined by the present writers or by Dr. I. M. Boykin; in the other cases accurate reports have been secured by letter or by interviews with the Social Service workers of the Hospital. Thirteen of these 150 cases were considered too recent for inclusion as "end-results," so that we have traced 100 out of 139 cases, or 72 per cent, of the entire number treated. (Table 1.)

TABLE I.—ALL FRACTURES (SITES)

	Total.	Non-operative.	Operative.
Fibula, shaft	5	5	
Tibia, shaft, above middle	4	4	
Tibia, shaft, below middle	16	15	1
Tibia and fibula, shafts, above middle	9	9	
Tibia and fibula, shafts below middle	22	14	8
Ankle A[2]	26	24	2
Ankle B	11	8	3
Ankle C	7	7	
Total	100	86	14

[1] This does not include tenotomy of the tendo Achillis for reduction, 2 cases; nor Steinmann pin extension from os calcis, 7 cases; nor 1 case of arthrotomy and suture of knee for hemarthrosis.

[2] See footnote to Table IV.

The tables presented herewith are compiled in accordance with the plan of the Fracture Committee of this Association in its 1915 report. It is worth while recalling once again the *definitions* of this report: The *anatomical result* denotes the

position assumed by the fragments of bone at the time of consolidation; in children, especially, a *bad* anatomical result in this sense may eventually prove to be a very good anatomical result, but in strict accord with our definition we have counted no anatomical result *good* unless at the time of consolidation there was present *accurate anatomical reposition* of the fragments. If such absolute anatomical reposition was not secured, the anatomical result has been recorded as "moderate," even if eventually the bone ends became rounded off so that no palpable deformity remained when the patient was last examined. Any gross anatomical deformity, and any appreciable shortening (over 2 cm.), have been classed as a *bad* anatomical result. (Tables II, III, IV.)

TABLE II.—ALL CASES

Anat.		Function		
		Good.	Moderate.	Bad.
Good .	81	67	13	1
Moderate	17	5	12	0
Bad . .	2	0	1	1
Total	100	72	26	2

TABLE III.—LEG CASES

Anat.		Function		
		Good.	Moderate.	Bad.
Good .	43 (77%)	39 (91%)	4 (9%)	0
Moderate	12 (21%)	4 (33%)	8 (66%)	0
Bad . .	1 (2%)	0	1 (100%)	0
Total	56	43 (77%)	13 (23%)	0

TABLE IV.—ANKLE CASES[1]

Anat.			Good.		Function Moderate.		Bad.	
Good	A 21, B 10, C 7	38 (86%)	A 16, B 7, C 5	28 (74%)	A 4, B 3, C 2	9 (23%)	A 1, B 0, C 0	1 (2%)
Mod.	A 4, B 1, C 0	5 (11%)	A 0, B 1, C 0	1 (20%)	A 4, B 0, C 0	4 (80%)	A 0, B 0, C 0	0
Bad	A 1, B 0, C 0	1 (3%)	A 0, B 0, C 0	0	A 0, B 0, C 0	0	A 1, B 0, C 0	1 (100%)
Total		44		29 (67%)		13 (30%)		2 (3%)

[1] A signifies fractures at ankle caused by external rotation of foot.
B signifies those caused by fibular flexion (abduction).
C signifies those caused by tibial flexion (adduction) of foot.
(Ashhurst and Bromer: Archives of Surgery, 1922, iv, 51)

So, also, with regard to functional results, we have followed the Fracture Committee's criterion that a *good* functional result implies the absence of any disability whatever. If there is pain in damp weather, if the patient tires more easily, if after long standing or walking the foot or leg swells, or if there is any limp we have classed the functional result as *moderate* only, even if the patient has resumed his normal occupation and makes the same wages. Any real incapacity interfering with work has been classed as a *bad* functional result: we are happy to say such a result occurred only in 2 patients, both with fractures at the ankle. One of them, aged forty years, did not come under our care for some weeks after her injury, when it was impossible to secure reduction; she has been unable to do any work since her accident, eight years ago. The other patient, with a bad result, also an ankle fracture, was a woman, aged forty-three years, who came under our care several days after injury, with great swelling and ecchymosis; as two attempts under a general anesthetic failed to secure reduction, she was operated on ten days after the accident, and though a good anatomical result was obtained, pain and disability persist to such an extent after two and one-half years that the result must be considered bad.

We give below a short summary of the cases in which a good functional result was not obtained. It may be noted that to all intents and purposes many of these patients have entirely satisfactory function; but as it is not perfect, we have classed them with *moderate*, not with *good* results, in accordance with the definitions already adopted.

Of the 26 patients who recovered only moderate function:

17 had and 9 had *not* a lessening of endurance.
10 had and 16 had *not* pain at any time.
4 had and 22 had *not* a limp.
3 had and 23 had *not* swelling.
3 had and 23 had *not* limitation of motion.

PATIENTS RECOVERING ONLY MODERATE FUNCTION

Shaft Fractures

Name and age.	Fracture.	Treatment.	Anatomical result.	Out of work.	Disability.	Same.	
						Job.	Pay.
Margaret C., 55, 1916	Into knee-jt.	Fr. box 1 wk.; circ. cast	Good	6 mos.	Knee flexes only to 90 degrees. Limps when tired	Yes	Yes.
Hugh B., 65, 1921	Upper ⅓ spiral	Fr. box 3 dys.; gypsum splints	Good	14 mos. (law suit)	Less endurance after 2 years	Less	Less.
Michael B., 57, 1922	Lower ⅓	Fr. box 4 dys.; then Steinmann pin	Mod.	9 mos.	Pain in wet weather slight limp	Yes	Yes.
Elizabeth C., 25, 1920	Lower ⅓ commin.	Gypsum splints	Mod.	4 mos.	Pain in wet weather less endurance after 3 yrs.	Yes	Yes.
Thomas D., 48, 1919	Lower ⅓ compound comminuted	Sinclair skate	Bad	10 mos.	Less endurance also had fract. patella, other knee	Yes	Less.
Samuel G., 32, 1916	Upper ⅓ compound commin.	Gypsum splints	Good	1 mo.	Knee flexes only to 70 degrees; pain in wet weather	Yes	Yes
William H., 34, 1916	Lower ⅓ compound	Steinmann pin	Mod.	8 mos.	Less endurance	Less	Less.
Agnes H., 47, 1915	Lower ⅓ comp. commin.	Steinmann pin	Mod.	?	Pain in wet weather after 5½ years	Yes	Yes.
Charles McK., 38, 1922	Lower ⅓ comp. commin.	Steinmann pin	Good	6 mos.	Pain and swelling toward night after one year	Yes	Yes.
John M., 32, 1922	Double fr. of tib. and fib., comp.	Smith clamps and Steinmann pin	Mod.	9 mos.	Less endurance. Wore brace 1 yr.	Yes	Yes
John P., 37, 1916	Commin. into knee	Arthrotomy for hemarthrosis; gypsum splints	Mod.	3 mos.	Slightly less endurance. Limps in fast walking	Yes	Less.
Malcolm, S., 16, 1921	Lower ⅓ comp. commin.	Steinmann pin	Mod.	3 mos.	Pain in wet weather Less endurance	Yes	Yes.
Jennie S., 60, 1920	Lower ⅓ comminuted	Gypsum splint	Mod.	6 mos.	Pain; swelling; less endurance	?	?
		Ankle Fractures[1]					
Philipina B., 66, 1921	Ankle A 2 x	Fr. box 6 days. Gypsum splints	Mod.	4 mos.	Swelling. Less endurance. (Has generalized arthritis deformans)	Yes	Yes.
Hiram C., 54, 1912	Ankle A 2 x	Fr. box 17 days Tenot. T. Achillis and gypsum splints	Mod.	6 mos.	Less endurance. Had former severe injury to both knees	Yes	Yes.
Patrick D., 67, 1919	Ankle A 2 x	Fr. box 2 wks. Circ. cast	Good	?	Pain at times; less endurance	Less	½
James O'M., 47, 1921	Ankle A 1	Adhesive strapping	Good	Nearly 1 year	Some pain; less endurance	Yes	Yes.
Ida E., 61, 1920	Ankle A 2 x	Gypsum splints	Mod.	6 mos.	Pain in wet weather Less endurance	Less	Less.
Sarah B., 54, 1907	Ankle A 2 with post. subluxation	Fr. box 13 days Tenot. tendo Ach.	Mod.	?	Limp. Less endurance	Yes	Yes.
Thomas M., 28, 1921	Ankle A 1	Fr. box 3 dys. Gypsum splints	Good	6 mos.	Painful, rigid, flat-foot. Less endurance	Less	Less.
Elmer E., 25, 1920	Ankle B 2a	Screw fixation	Good	6 mos.	Pain in wet weather Can walk 2 miles	Yes	Yes.
Martin H., 46, 1920	Ankle B 2a	Fr. box 3 dys. Gypsum splints	Good	3 mos.	Less endurance	Less	Less.

PATIENTS RECOVERING ONLY MODERATE FUNCTION—(*Continued*)

ANKLE FRACTURES—(*Continued*)

Name and age.	Fracture.	Treatment.	Anatomical result.	Out of work.	Disability.	Same.	
						Job.	Pay.
Catherine McG., 39, 1919	Ankle B 2 b	Fr. box 12 dys. Gypsum splints	Mod.	6 mos.	Wore brace 1 yr. Less endurance		
Alex V., 28, 1921	Ankle B 3 comp. commin.	Plate immed.; removed 10 dys. (infect.); then Steinmann pin	Good	Over 18 mos.	Wore brace 1 year; stiff ankle	No	Less.
Albert M., 42, 1920	Ankle C 2	Fr. box 3 dys. Gypsum splints	Good	6 mos.	L. foot turns easily. Wears arch supporter; very heavy man. R. ankle also fractured at same time, gives no disability	Yes	Yes.
Barbara P., 59, 1920	Ankle C	Fr. box 6 dys. Gypsum	Good	8 mos.	Pain at times. Less endurance. Has varicose veins	No	Less.
PATIENTS RECOVERING WITH BAD FUNCTION—ANKLE FRACTURES							
Rose M., 40, 1914	Ankle A 2	Fr. box; circ. cast	Bad	Yes still after 6 years	Complete		
Susan P., 43, 1920	Ankle A 2 x	Screw fixation (screws removed 10 mos. later for pain)	Good	12 mos.	Pain in wet weather Limited motion. Less endurance	Less	Yes.

[1] See footnote to Table IV.
A 1 signifies first stage of fracture by external rotation.
A 2 signifies second stage of fracture by external rotation, etc.
x signifies presence also of posterior marginal fragment.

Among our 100 end-results *shortening* was noted in 4:

1. A man, aged fifty-seven years, had 1 cm. shortening, following a comminuted fracture treated by Steinmann nail traction; he was out of work nine months, and his anatomical and functional results were both classed as moderate, since he had appreciable shortening and had a slight limp and complained of pain in wet weather.

2. A man, aged thirty-seven years, had 2 cm. shortening following a comminuted fracture of the upper ends of the tibia and fibula involving the knee-joint, with marked hemarthrosis for which arthrotomy was

required; he was out of work three months, and his anatomical and functional results were classed as moderate, as he limped in fast walking and had slightly less endurance, though he resumed his job at his former wages.

3. A man, aged forty-one years, had 2 cm. shortening; he refused operation for a simple fracture of the shaft with marked displacement; was out of work fifteen weeks; and recovered perfect function.

4. A man, aged forty-eight years, with 2.5 cm. shortening, following a compound comminuted fracture of the shafts, which was inefficiently treated by extension through a Sinclair skate; he was out of work ten months, and recovered with bad anatomical result (shortening over 2 cm.) and only moderate function, as he had less endurance and made less wages, though working at the same job, as before his injury. He had also a fracture of the patella of the other knee.

One patient had lengthening of 1 cm. in the fractured leg following plating for irreducible displacement. He was out of work fourteen months (from no apparent cause) and secured good anatomy and good function. The plate was still in place when last seen over six years after the injury. Bony union was secured in all the 152 cases treated; there were 2 or 3 cases in which union was delayed, especially in compound fractures, but no case of non-union was seen. Nor did any case of peroneal paralysis occur.

The question of shortening is of more importance in leg fractures than in those of the femur; for in spiral fractures, which are frequent in the leg, any shortening implies rotation of the lower fragment; and as both the knee and ankle are hinge-joints, any change in their relative axes entails great disability—much greater disability than in the femur, where voluntary rotation at the hip serves largely to compensate for any rotatory deformity of the lower fragment in a case of malunion.

TABLE V.—ALL CASES (NON-OPERATIVE)

Anat. result.	Total.	Functional result. Good.	Moderate.	Bad.
Good . . .	70 (82%)	59 (84%)	11 (16%)	
Moderate . .	14 (16%)	3 (21%)	11 (79%)	
Bad . . .	2 (2%)	....	1 (50%)	1 (50%)
Total . .	86 (100%)	62 (72%)	23 (27%)	1 (1%)

TABLE VI.—ALL CASES (OPERATIVE)

Anat. result.	Total.	Functional result. Good.	Moderate.	Bad.
Good . . .	11 (78%)	8 (73%)	2 (18%)	1 (9%)
Moderate . .	3 (12%)	2 (66%)	1 (33%)	
Bad . . .				
Total . .	14 (100%)	10 (72%)	3 (21%)	1 (7%)

TABLE VII.—SIMPLE FRACTURES (ALL SITES)

Anat. result.	Total.	Functional result. Good.	Moderate.	Bad.
Good . . .	71 (82%)	60 (85%)	10 (14%)	1 (1%)
Moderate . .	13 (16%)	4 (36%)	9 (64%)	
Bad . . .	1 (2%)	..	..	1 (100%)
Total . .	85 (100%)	64 (75%)	19 (22%)	2 (3%)

TABLE VIII.—COMPOUND FRACTURES (ALL SITES)

Anat. result.	Total.	Functional result. Good.	Moderate.	Bad.
Good . . .	10 (67%)	7 (70%)	3 (30%)	
Moderate . .	4 (26%)	1 (25%)	3 (75%)	
Bad . . .	1 (7%)	..	1 (100%)	
Total . .	15 (100%)	8 (53%)	7 (47%)	

TABLE IX.—FUNCTIONAL END-RESULTS (ALL CASES)

	Total.		Good.		Moderate.		Bad.	
	A.S.A.[1] 1921.	Ashhurst & Crossan.	A.S.A.	A. & C.[1]	A.S.A.	A. & C.	A.S.A.	A. & C.
Simple	625 (68%)	85 (85%)	468 (75%)	64 (75%)	114 (18%)	19 (22%)	43 (7%)	2 (3%)
Compound	289 (22%)	15 (15%)	180 (62%)	8 (53%)	69 (24%)	7 (47%)	40 (14%)	
Total	914	100	648 (71%)	72 (72%)	183 (20%)	26 (26%)	83 (9%)	2 (2%)

[1] A. S. A. stands for American Surgical Association's 1921 Report on Fractures of Tibia and Fibula.
A. and C. stands for present report by Ashhurst and Crossan.

TABLE X.—AVERAGE PERIOD OF DISABILITY (ALL CASES)

Fracture.	Total A.S.A., 1921.	Disability, months.	Total A. and C.	Disability, months.	Simple A.S.A.	Disability, months.	Simple A. and C.	Disability, months.	Compound.		Compound.	
									A.S.A.	Disability, months.	A. and C.	Disability, months.
Shafts . .	413	5·2	51	4·3	331	4·7	39	3·8	82	7·0	12	5·5
Ankle . . .	233	4·4	35	4·3	225	4·0	35	4·3[1]	8	5·7		
Total . . .	646	4·9	86	4·3	556	4·6	74	....	90	6·8	12	5·5

[1] One case of simple fracture of ankle resulted in complete disability not included in above.

TABLE XI.—INFLUENCE OF AGE ON FUNCTIONAL RESULT

Anat. result.	Total.	Functional result: Good.	Moderate.	Bad.
Under 15 years.				
Good	17 (85%)	17 (100%)		
Moderate	3 (15%)	2 (67%)	1 (33%)	
Bad				
Total	20 (100%)	19 (95%)	1 (5%)	
Over 15 years.				
Good	64 (80%)	50 (78%)	13 (20%)	1 (2%)
Moderate	14 (18%)	3 (21%)	11 (79%)	
Bad	2 (2%)	..	1 (50%)	1 (50%)
Total	80 (100%)	53 (65%)	25 (33%)	2 (2%)

TABLE XII.—AVERAGE PERIOD OF DISABILITY

Fracture.	All cases.	Av. period of disability (months).	Simple fract.	Av. period of disability.	Compound fracture.	Av. period of disability.
Fibula, shaft	5	2.5	4	2.6	1	2.0
Tibia, above middle	2	3.5	2	3.5		
Tibia, below middle	15	3.1	13	3.0	2	3.5
Tibia and fibula above middle	9	4.7	7	5.0	2	3.5
Tibia and fibula below middle	20	5.3	13	4.4	7	7.1
Total	51		39		12	
Ankle A[1]	21	4.3	21[2]	4.3		
Ankle B	9	3.9	9	3.9		
Ankle C	5	5.0	5	5.0		
Total	35		35[2]			

[1] See footnote to Table IV.
[2] One with complete disability not included in the above.

It was pointed out in the 1921 report on "Fractures of the Tibia and Fibula," that the reporters of many of the cases then analyzed had been less strict than the committee in adhering to its definitions, inasmuch as some reports then received classed as "good" anatomical results, cases in which shortening of as much as 3 cm. was recorded; and as "good" functional results cases in which pain in damp weather persisted or where there was evident, but not disabling, limitation of motion, and where disability was "partial," not entirely "absent." In comparing the results there recorded with those now presented (Table IX),

this comparatively optimistic view afforded by the 1921 statistics should be kept in mind. We repeat that in our own cases only those results have been classed as good functionally in which there was complete absence of any symptoms referable to the fracture. One patient was encountered who maintained that since he had broken his leg it was even better than before the accident.

Simple Fractures. *Treatment on Admission.* The usual course of treatment followed in these cases has been about as follows: On admission to the hospital the skin is carefully washed, and if necessary shaved and rubbed with alcohol, so as to prevent infection of any bullæ which may develop, or of a more deeply placed hematoma. We are convinced such infection often arises from neglect in properly caring for the skin surface. The leg is then placed in a fracture box, gross displacements being corrected, and efforts being made to have the pillow inside the fracture box of such size and thickness as to maintain the limb in as nearly correct position as possible. Pads of raw cotton, folded towels or other material are used between the fracture box and the pillow (not between the latter and the leg) to aid in maintaining reduction. The patient is then sent in his bed (all beds are on wheels) to the *x*-ray laboratory. In fractures of the shafts of the leg bones no further reduction is attempted unless gross displacement is shown by the *x*-rays. In ankle fractures every effort is made to secure accurate anatomical reposition of the fragments; but in fractures of the shafts we have been content to secure union without appreciable shortening and without axial or rotatory displacement, even if anatomical reposition was not secured. Thus (Tables III and IV) in leg fractures we secured only 77 per cent of anatomical repositions (resulting in good function in 91 per cent of the cases) and in ankle fractures 86 per cent of anatomical repositions (with good function only in 74 per cent of these cases).

Cases without Gross Displacements. Usually the leg has remained in the fracture box several days, or until there occurred subsidence of the swelling present on admission or developing

within a few hours. Formerly circular plaster-of-Paris dressings were applied at this stage, and were left undisturbed until union was believed to have occurred. But since about 1914 such dressings have been abandoned entirely, in favor of *moulded gypsum splints*, as introduced by Stimson: the patient's leg, from toes to mid-thigh, is bandaged not too snugly with flannel bandages, and over these the gypsum splints are applied. These splints are made by soaking (one at a time) the ordinary roller bandage of plaster of Paris (about 10 cm. wide) in warm water, and then running it back and forth on itself as it is unrolled, on a smooth surface (table top) until a splint of suitable thickness and length has been secured. Usually two or at the most three roller bandages are used for each splint, three of which are made, each being applied to the leg before the next is prepared. The first splint passes down the back of the limb from well above the knee under the calf and heel, and is turned up along the sole of the foot to terminate at the toes. This splint is then bandaged snugly to the leg with circular turns of a flannel bandage, carefully covering all parts of the splint so that the splint next to be applied will not adhere to the first. The second splint is applied with one end on the dorsum of the foot, passing thence around the outer border of the foot, across the sole and up the inner side of the limb to mid-thigh: its initial extremity should not extend so far across the dorsum of the foot as to touch the edge of the same splint as it passes from the sole up the inner side of the leg, since if these moist margins come into contact one will adhere to the other. This second splint is then carefully covered in by a flannel roller, and over it the third splint is applied, covering the dorsum of the foot, the sole and the outer side of the leg and knee, and is itself held in place by a roller bandage. The great advantage of these splints applied in this way is not only that there need be very little disturbance of the fracture during their application (very much less than in the application of a circular case), but that injurious circular constriction never occurs, and, what is probably most important of all, that the two lateral splints can be conveniently removed

weekly or oftener for proper "dressing" of the soft parts without disturbing the posterior splint or the fragments. Patients with these splints have their fractures just as securely fixed as with a circular case and may be allowed out of bed and the use of crutches with the same impunity. Crutches seldom are used, nor is the patient allowed to have his leg dependent until three or four weeks after the injury. When union appears good the patient is encouraged to bear a little weight on the limb, and then one of the gypsum splints is discarded at a time, until usually about the sixth to the eighth week the patient is using crutches without any splints. Seldom has troublesome swelling occurred during convalescence. This is attributed to the care of the soft parts during the time the bones were uniting. Weekly or oftener, when the lateral splints are removed, the patient is able to make active movements of the foot without disturbing the fracture; and as soon as enough union is present to prevent displacement of the ends (usually after two weeks) the entire limb can be raised by the surgeon from the posterior splint and a little motion may be permitted at the knee. Very light *effleurage* is employed by the surgeon at each dressing. This amounts to little more than sponging the skin with alcohol, drying it well and rubbing in some talc powder with the hand. It is seldom found necessary to have formal treatment by baking and massage instituted during convalescence when proper care has been taken of the soft parts from the first. Perhaps we could have secured a larger proportion of perfect results in ankle fractures if we had been more insistent on the patients wearing proper shoes after being dismissed from hospital care. Not a few were found later to be partly disabled from flat-foot, presumably due to neglect of such precaution.

In shaft fractures with marked displacement and in ankle fractures in every case with any displacement whatever, efforts are made as soon as possible to correct the displacement. For this a general anesthetic is given almost always. In *shaft fractures* attempts have been made to secure reduction by dressing the leg in Pott's position (lying on its outer side with the knee flexed), but with-

out success: subsequent *x*-ray examination has seldom shown any marked improvement in position of the bones, even when the appearance of the soft parts indicated good reduction; and in a few cases the displacement has been increased by using

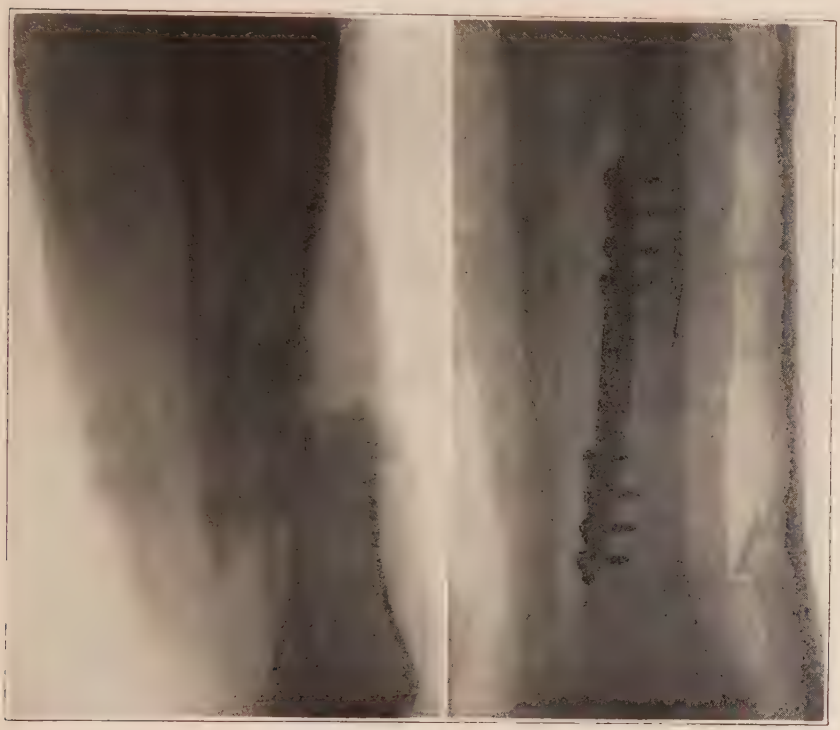

FIG. 1.—E. G., man, aged thirty-two years, September 16, 1916, on admission. Left: Compound fracture of tibia and fibula from kick by horse. Free bleeding was controlled by compress. Attempted reduction on fracture table, with mechanical traction under anesthesia was not successful. A plate was applied seven days after injury. Right: Appearance ten days after operation. The patient was out of work six months. A perfect anatomic and functional result was obtained.

Pott's position. In some cases with marked displacement (Fig. 1) it is evident that attempts at closed reduction will do more damage to the soft parts than will an operation,

and in such cases *no attempts at reduction* are made until the bones are exposed at operation. In other cases, particularly

FIG. 2.—Equinus-lever of Gwilym G. Davis. The leather strap passes across the instep, and the cross-bars beneath the ball of the foot. The operator, steadying the far end of the lever in his own axilla, has complete control of the patient's foot.

comminuted fractures, it is evident that even if secured, reduction could not be maintained without continuous extension; and in these the principle of skeletal traction has been employed by

means of the Steinmann pin through the calcaneum. This plan will be described when speaking of compound fractures. In 3 cases of fractures in the upper third of the tibia, the ordinary

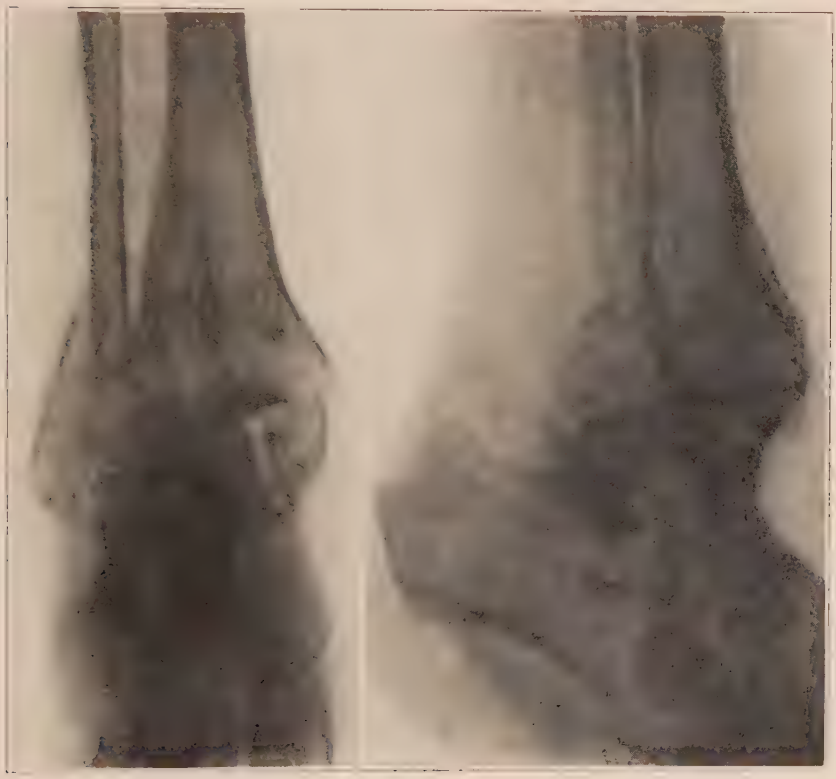

FIG. 3.—L. K., woman, aged sixty-nine years, September 5, 1916, on admission. Left: Ankle fracture by external rotation, second degree: (1) Spiral fracture of fibula through inferior tibiofibular joint, (2) fracture of internal malleolus; complicated by a posterior marginal fracture of the tibia, and with posterior subluxation of the foot (A2x); anteroposterior view before reduction. Right: Lateral view.

Buck's extension apparatus was advantageously employed. In ankle fractures reduction frequently may be secured by manual manipulation under anesthesia; in a few cases we have employed with advantage the equinus lever of G. G. Davis (Figs. 2, 3, 4),

in others it has failed to procure reduction (Figs. 5 and 6). In 2 cases (seen in 1907 and in 1912) unreduced for two weeks and for three weeks respectively it was necessary to do tenotomy of the tendon of Achilles; these patients did not secure perfect

FIG. 4.—Same case as in Fig. 3. Left: Appearance after reduction by means of the equinus lever; gypsum splints (Stimson) were used (antero-posterior view). Right: Lateral view after reduction. The patient was in hospital about eight weeks, and resumed her housework on her return home. A perfect anatomic and functional result was obtained.

function; each of them was fifty-four years of age and both recovered with somewhat lessened endurance and slight limp. If reduction of an ankle fracture cannot be secured after one or two attempts under general anesthesia, operative reduction is advised; it was adopted in 6 out of 79 cases of simple fracture.

and in all of them screw fixation was employed (Figs. 5 and 6). Some patients refuse any operation (Fig. 7).

Delbet's Gypsum Apparatus.[1] During the last year we have employed this apparatus in every case of leg fracture in which it did not seem contraindicated; that is, in about 10 cases. We have to thank Dr. Mercier, Dr. Bourgeois and their staff, at Notre Dame Hospital, Montreal, for demonstrating the appli-

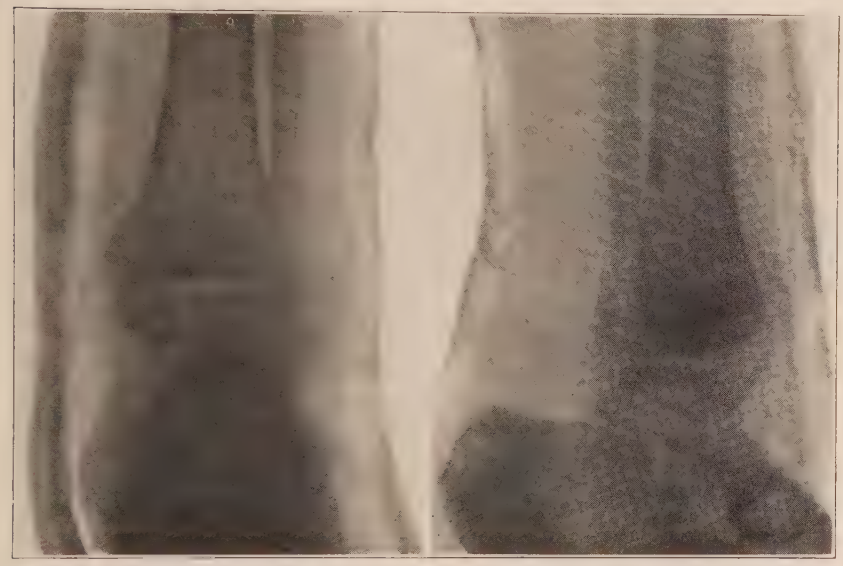

FIG. 5.—C. K., man, aged fifty-two years, January 13, 1917. Left: Ankle fracture (A2x) after two attempts at reduction, the second attempt aided by the equinus lever; anteroposterior view. Right: Lateral view. Reduction was not obtained.

cation of this apparatus. The chief advantages of the apparatus are: (1) It is applied during continuous traction on the foot by weight and pulley, this traction serving to secure sufficiently accurate reduction of fractures of the shafts without any anesthetic. (2) When applied and as soon as the plaster of Paris has set the weight extension may be removed, since the apparatus

[1] Delbet, Pierre: Méthode de traitement des fractures, Paris. 1916.

fits snugly to the condyles of the tibia above and to the malleoli below, preventing any subsequent shortening. (3) It leaves both the knee- and ankle-joints free, so that the patient can move them from the start, and thus by constant use of his leg muscles

FIG. 6.—Same case as in Fig. 5, showing result of arthrotomy and screw fixation, eleven days after injury. The patient was out of work thirteen weeks. A perfect anatomic and functional result was obtained. The screws were still in place over seven years after operation.

can materially shorten the period required for consolidation of the bones and prevent the occurrence of the atrophy of disuse. (4) The patient can leave his bed and begin to walk with crutches during the first week or ten days. (5) Delbet found in his own

cases that the *average* time the splint was worn was thirty-five days, the fragments being then firmly united and all external support discontinued.

FIG. 7.—C. McG., woman, aged thirty-nine years, July 17, 1919, on admission. Left: Ankle fracture (B2b), typical Pott's fracture, with (1) fracture of internal malleolus, (2) diastasis of tibia and fibula and (3) fracture of fibula well above the inferior tibiofibular joint (anteroposterior view). Right: Lateral view, showing posterior subluxation of foot (note absence of a posterior marginal fracture of tibia). Patient first came under the authors' care two weeks after injury. Three attempts at reduction under an anesthetic failed to secure anatomic reposition. The patient refused operation. She was out of work six months, but held her former position at the same wages. A moderate anatomic and functional result was obtained. Pain after much motion, and less endurance were her complaints three years later.

The materials required for the application of the apparatus are:

1. A hard, flat table, with no padding, to support the fractured leg; such support prevents the posterior sagging of the fragments

FIG. 8.—Method of application of Delbet's apparatus for fractures of the leg. The board is laid on the bed, with pulley for weight extension. There are traction loops over the instep and heel, and a Scultetus bandage beneath the leg.

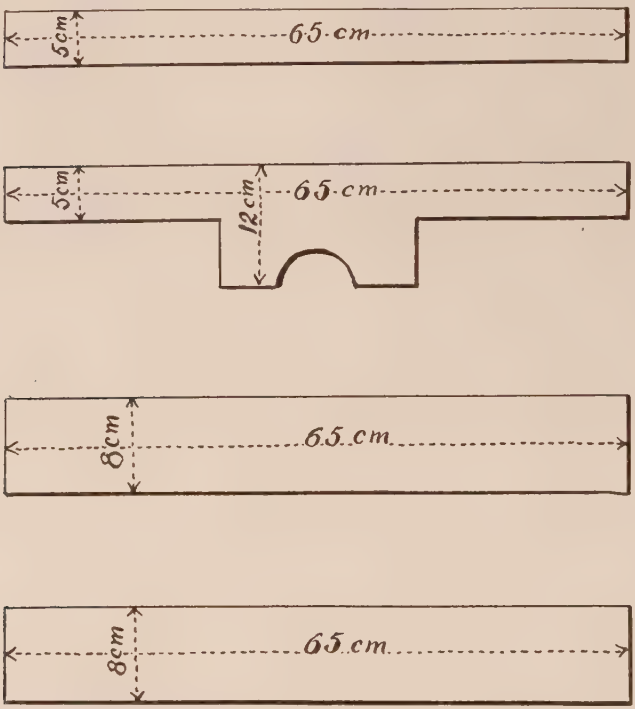

FIG. 9.—Diagram showing the dimensions of the crinoline bands of which Delbet's apparatus is composed. The two lateral bands are made of twenty-four thicknesses of crinoline, and the circular bands of sixteen thicknesses each.

always seen in shaft fractures when the limb is placed on an upholstered surface, such as even the firmest mattress. In our own work we have used a thin board which is laid on top of the mattress (Fig. 8), and we have had a pulley attached to the board at such a height that traction over it will be directly in the axis of the leg bones, and with the pulley movable laterally on its axis, so that any lateral deformity at the site of fracture

FIG. 10.—Delbet's apparatus for fracture of the leg. The weight is borne on the foot itself, not on the ends of the splint. The lower band crosses above the prominence made by contraction of the tendon of the tibialis anticus. The upper band should not come so far below the tubercle of the tibia as to press on the crest of the tibia. The space for projection of heel should be noted.

can be corrected by shifting the pulley to right or left without in any way disturbing the limb.

2. A Scultetus (many-tailed) bandage, made by stitching together at their centers enough rather narrow strips of bandage (each about 50 cm. long) to extend from the heel to the knee. Its ends may be wrapped in cardboard for convenience in handling.

3. Weights for Traction: From 16 to 22 pounds (7 to 10 kg.) are required.

FIG. 11.—A. H., woman, aged forty-seven years, December 18, 1915, on admission. Right: Compound comminuted fracture of tibia and fibula from a fall on icy street. The bones, which protruded through the skin on both sides of the leg, were swabbed with iodin and reduced (anteroposterior view). Left: Lateral view. Steinmann nail traction was employed for eighteen days (compare Figs. 12 and 13).

4. Material such as tarlatan or crinoline for making the apparatus. This should be cut into pieces of the following dimensions: The *two* side splints are each of 24 thicknesses and

65 cm. long by 8 cm. wide; the band which encircles the leg below the knee is of 16 thicknesses and measures 65 cm. long by 5 cm. wide; the band which encircles the malleoli and heel

FIG. 12.—Same case as in Fig. 11. Left: Anteroposterior view, five days after traction of 7.5 kg. (16 pounds) by Steinmann nail. Right: Lateral view. Shortening is almost overcome, but there is still lateral displacement of more than half a diameter.

is also of 16 thicknesses, 65 cm. long, and cut so that its middle portion is 12 cm. wide by 19 cm. long while its right and left thirds are only 5 cm. wide and each 23 cm. long; in the middle

third a semicircular notch is made in the projecting portion to receive the point of the heel. Each of these four splints should be basted together down its middle, for convenience in handling (Fig. 9).

FIG. 13.—Anteroposterior and later views of case shown in Figs. 11 and 12, two weeks after traction of 7.5 kg. (16 pounds) by Steinmann nail. Shortening is overcome, reduction fair and lateral displacement less than one-quarter a diameter. The anatomic and functional result is moderate (after seven years the patient still has pain in wet weather).

Application of the Delbet Apparatus. The board with pulley attached is placed under the fractured leg with as little disturb-

ance as possible, and an assistant holds the patient's toes to prevent rotation of the leg. The leg should be cleansed and if

FIG. 14.—A. V., man, aged twenty-eight years, September 17, 1921, on admission. Compound fracture of left tibia and fibula involving the ankle-joint (B3): (1) Fracture of entire lower end of tibia (representative of the internal malleolus in the typical Pott's fracture), followed by (2) fracture of the fibula well above the inferior tibiofibular joint, resulting from a fall from a height, the patient landing on the foot. Immediate operation was performed.

necessary shaved. It should always be very well powdered (talc powder is excellent).[1] The Scultetus bandage is then

[1] As the plaster-of-Paris splints are to be applied directly to the bare skin, discomfort may arise from the hairs sticking to the plaster while moist. Shaving will prevent this, but we have found generous powdering sufficient. It is more satisfactory than grease, as the latter has a tendency to prevent the plaster of Paris from setting.

carefully drawn under the leg, without disturbing the latter more than is absolutely necessary. Next a stirrup for traction is made by passing one strip of flannel bandage (about 3 cm.

FIG. 15.—Same case as in Fig. 14 one week after operation. Ten days after operation the plate was removed because of infection, and a Steinmann nail was applied (Fig. 16).

wide by 45 cm. long) beneath the tendon of Achilles, and another of the same dimensions across the dorsum of the foot just below the ankle-joint. These strips are arranged so that their cen-

ters lie in the midline of the heel and ankle and their ends are overlapped just *below* and *posterior* to the malleoli. While the surgeon holds the ends properly overlapped, the nurse sews them together: this may be facilitated by turning the over-

FIG. 16.—Same case as in Figs. 14 and 15. A Steinmann nail was inserted, September 27, 1921, ten days after injury, when the plate was removed. The drainage tube emerging through counter-incision at dependent point may be seen. The Steinmann nail was removed, November 1 (five weeks later).

lapped ends temporarily upward above the malleoli. Next the free ends of these traction strips are sewed or tied to each other a convenient distance below the sole of the foot; and to the loop thus formed is fastened the rope passing over the pulley and supporting the weights. The weights should be added

gradually. Repeated measurements of the fractured leg (from the lower border of the patella to the tip of the internal malleolus) will show its shortening being gradually overcome as the weights

FIG. 17.—Same case as in Figs. 14, 15 and 16, one year after injury. The tunnel for nail is still visible in the calcaneum in the lateral view. The patient wore a brace for a year. He was out of work eighteen months. A good anatomic result with moderate function was obtained. The only disability is a stiff ankle, but the patient cannot resume the same position (which involves climbing telegraph poles) and makes less wages.

are cautiously increased up to a maximum of about 10 kg. Frequently less weight is enough. As soon as the weights begin to act the patient's pain ceases. No effort should be made to push or mold the bone ends into position. Any such attempt

FIG. 18.—J. M., man, aged thirty-two years, August 9, 1922, after operation performed immediately on admission. Double compound fracture of tibia and fibula, showing temporary clamps used to fix the compound fractures; also a Steinmann nail in calcaneum, and drainage tube emerging through dependent counterincision. The clamps and traction nail were removed three weeks later. The patient was in hospital ten weeks, and was discharged with firm union, wearing a brace. He was out of work nine months. Anatomic and functional result was moderate (has less endurance than before injury, but no other disability).

will produce pain and muscular spasm and will totally defeat the object to be gained, which is the gradual reduction of the deformity. The line of pull may be altered readily by shifting the pulley to one side or the other without causing the patient any discomfort. As soon as reduction has been secured, as ascertained by measurement and the restoration of the normal axis of the limb, a plaster cream should be made. About six cupfuls of cold water are placed in a rather shallow but large basin and plaster of Paris is slowly sifted into the water until the powder no longer sinks rapidly. By this time a little plaster will have collected on the bottom of the basin, and then, but not until then, should the hand be put into the cream for stirring it. This stirring should be done slowly and regularly and uniformly; no churning is permissible. Delbet says it is better to have a cream too thin than too thick. When it is of the consistence of very thin cream, all four of the crinoline splints should be placed in the mixture at the same time, to prevent unequal distribution among them of the plaster of Paris.[1] When they have become well impregnated, they are taken out and spread out flat and in order. The band which goes around the malleoli is drawn under the bridge formed by the tendo Achillis, *without moving the leg*, and is pulled down by seesaw motions until it is arrested by the heel; for the time being its ends are spread out flat on the fracture board. The band for below the knee is next pulled beneath the popliteal space and drawn downward by seesaw motions until arrested by the calf; and its ends are spread out flat on the fracture board. Next the two lateral bands are applied, beginning just below the level of the knee-joint (this is at the lower border of the patella) and extending to within 1 cm. of the sole of the foot at the heel; the bands are then doubled back on themselves, so that the lower one-third of the leg is supported by a double thickness. When these lateral bands have been gently molded to the sides of the leg

[1] If there is much starch ("sizing") in the crinoline, it is best to soak the splints first in plain water, so as to dissolve the starch. They then absorb the plaster cream better.

and the malleoli, the circular band already in place beneath the heel is drawn snugly around the malleolar region on top of the two lateral bands, but *without any constriction*. The long ends of this circular malleolar band are to be crossed on themselves across the front of the leg at a point *above where the tendon of the tibialis anticus becomes subcutaneous:* this point may be observed on the normal leg and the splint arranged to correspond. Neglect of this will lead to the development of a pressure sore at this point. Finally the upper circular band, surrounding the condyles of the tibia, is drawn snugly *but without constriction*, around the leg below the knee and its ends are crossed in front at a point above the crest of the tibia, which is also liable to pressure sores. The usual mistake is to put this upper circular band too high, so that it interferes with flexion of the knee. (Fig. 10.)

Last of all the Scultetus bandage is fastened up, beginning at the heel; and the whole apparatus is carefully molded to the malleoli and tibial condyles as it sets. As soon as it has become reasonably firm the weights are removed, *and the stirrup applied for extension is cut and withdrawn;* neglect to remove it may cause a slough over the dorsum of the foot or over the heel. Usually the weights do not have to remain in place for more than fifteen or twenty-five minutes from beginning to end of the procedure. The Scultetus bandage is removed in twenty-four or thirty-six hours, leaving the gyspum apparatus in place. To ensure proper "setting," the plaster of Paris must be fresh and of good quality; and it is a wise precaution to sprinkle some of the dry plaster over the various bands just before they are applied to the leg.

For the first day or two after the Delbet apparatus has been applied, it is well to keep the limb well elevated on pillows and surrounded with ice-bags. This tends to prevent injurious swelling and formation of blebs. In a few cases it may be necessary to remove the apparatus on account of the swelling. Blebs appear not beneath the gypsum apparatus but on the exposed skin. They should be punctured with a sterile knife dusted with sterile powder and then usually may be disregarded,

giving no further trouble. If the apparatus is not applied until swelling has developed, it usually is necessary to apply a second one within a few days, when subsidence of the swelling causes it to become loose. Of 123 cases under Delbet's care a second apparatus had to be applied in 68; 28 patients had 3 plasters and 3 patients had 4 plasters—only in 20 cases was a single application of the apparatus sufficient.

The subsequent care and treatment of patients wearing the Delbet splint form an integral part of the treatment and must never be neglected. Within the first week or ten days the patients are gotten up on crutches and taught to walk; putting the foot flat on the floor, they must be made to dorsiflex the ankle and bend the knee at each step, thus bringing into function both joints and preventing the atrophy of disuse or joint stiffness. This active mobilization has a singular tendency to promote rapidity of union in the fracture. Delbet says in his cases of simple fracture the average stay in hospital was twenty-four days, whereas the statistics of the Public Health Service of Paris show that for simple fractures of the legs under the usual treatment the average stay in the hospital is from two and one-half to three months. In these latter cases there is first a period of thirty-five to forty-five days in the circular plaster-of-Paris case, and then a further period of two or three months or longer for massage, etc. This makes the total period of disability between four and five months for simple fractures of the leg; which corresponds to the period of disability in the statistics of the Fracture Committee of the American Surgical Association. While Delbet says he does not accurately know the end-results in patients treated by his method, he is convinced the patients are absolutely cured when the apparatus is removed about the end of the fifth week (thirty-five days). Out of 65 cases traced, he considered "good" results were obtained in 60, though 10 of these patients limped and 3 had shortening of 3 cm. Evidently he is not as strict in his definition of good results as the Commitee of the American Surgical Association. Delbet uses this apparatus also in ankle fractures, considering it especially adapted

to them. Of 55 end-results of ankle fractures, he considered 53 good results. He thinks his apparatus least satisfactory for fractures in the upper third of the tibia and fibula, where fixation of the fragments is nearly impossible unless the knee-joint also is immobilized.

The patients in whose cases we have used the Delbet apparatus have been treated too recently to be included in the present report. However, we have found that posterior sagging of the fragments, not infrequent with the former methods of treatment, can almost always be overcome; that the shortening almost always is inappreciable or absent; that the patients get about on their feet sooner; and that union occurs more rapidly. The Delbet splint was also found very useful in a case of delayed union; applied at the end of the third month, union was firm in three weeks' time. In recent cases it should be applied at *once*, before the leg and ankle have swelled. Early reduction may prevent too great swelling. If this swelling occurs in spite of the prompt application of the apparatus, there will be less tendency for shortening and deformity to develop when the apparatus is removed several days after the injury than there was when it was applied; and if the shortening and deformity are allowed to remain uncorrected at the time of the accident, they become daily more and more difficult to overcome.

Compound Fractures. There were 15 cases of compound fracture among the 100 patients traced, 14 of the shafts and only 1 involving the ankle-joint. They have readily divided themselves into two classes: (1) Those with small skin wounds (2 or 3 cm. or less in length) usually produced by the bones breaking through the skin; and (2) those with large lacerations of the skin and muscles, usually produced by direct violence.

1. The former class, with *small skin wounds*, have been treated as simple fractures: that is to say, the leg has been cleansed and the wound or wounds covered by alcohol compresses and allowed to heal without primary operation. If operation seemed required for reduction, as it did in 4 out of 13 cases of this nature, it was not undertaken until the period at which it would have

been done if the fractures had been simple and not compound: by this time (a week or ten days after the injury) the wounds in the soft parts had healed, and the fracture had been converted into the simple type (Fig. 1). If operation did not seem indicated, the Steinmann nail extension was preferred to the Delbet splint when gross displacements of the fragments existed, and especially in comminuted fractures (Figs. 11, 12, 13).

The *Steinmann nail* may be inserted with local anesthesia only, but a general anesthetic (gas) is preferable. The heel being properly sterilized is held firmly in the surgeon's left hand and a longitudinal incision, about 1 cm. long, is made directly down to the calcaneum about half-way between the external malleolus and the sole, just posterior to the line of the fibula. The edges of this incision are held apart by an assistant, with Allis forceps, and the nail, fixed in its handle, is bored through the calcaneum, taking care that it passes transversely and not obliquely to the long axis of the leg; it passes through the bone readily as the surgeon keeps constantly pushing it ahead with a rotatory motion *in supination only:* to pronate the hand while boring the nail through the bone will unscrew the two halves of the nail at their junction. When the point is felt beneath the skin on the opposite side of the heel, a small longitudinal incision is made over it, the skin edges are held apart by Allis forceps and the point brought as far out beyond the skin as the other end projects on the opposite side of the heel. The handle is then detached and a snugly fitting piece of rubber tubing is passed over each end of the nail, so as to prevent the latter from coming into contact with the skin or subcutaneous fat at any point. Lambotte has pointed out that neglect of this precaution has often resulted in necrosis of the skin edges where these touch the nail; whereas when they are protected by rubber tubing, they remain healthy. Finally the tongs are applied, their junction with the nails is wrapped in abundant sterile gauze and the weights are attached. From 15 to 22 pounds (8 to 10 kg.) is sufficient. Usually we have employed a posterior gypsum splint (Stimson) along with the nail extension. After

ten days or two weeks the amount of weight is gradually diminished, controlling the position of the bones by the *x*-ray; and about the end of the third week or during the fourth week the traction apparatus is removed. This is readily done without an anesthetic, catching the projecting sharp point of the nail in a sequestrum forceps and holding it firmly while the blunt end is unscrewed with the handle which fits it, the two halves thus being extracted through their proper sides of the calcaneum without carrying any possible contamination across it.

Of the 10 cases in which skeletal traction by the Steinmann nail was employed, it proved efficient in 8, though in one of these cases the nail broke at its center screw-joint while the weights were attached. This accident occurred at the end of the third week, when it was time for its removal. Aside from causing the patient discomfort for a few hours, until its removal, no other inconvenience was experienced. In another case a defective nail broke in half at the screw-joint, as it was being inserted; the sharp end had just emerged from the bone on the distal side of the limb but could not be extracted. The blunt end was removed in its handle. The sharp end was temporarily disregarded; but when the patient was returned to the operating room a week later, for fixation of the tibia by plate, it was found, as had been anticipated, that enough rarefaction had already occurred around the remaining portion of the nail to allow of it being extracted easily, though only the tip of its sharp point was available for the hold of forceps (Fig. 1). In 1 case traction (instituted on the sixth day), with a weight of 22 pounds (10 kg.) on the nail, failed to improve the position of the fragments, which were subsequently plated.

Cultures were made in almost all cases from the sinuses through which the traction nails passed, at the time of removal of the latter. With one or two exceptions, which gave a growth of staphylococcus, all cultures remained sterile; and all, even those with positive cultures, healed rapidly when the nail was removed. Though the tunnel in the calcaneum may remain visible in *x*-rays for many months, no discomfort has been experienced

by the patients. One patient, however, fourteen months after the injury, still complained of hyperesthesia in the skin overlying the nail punctures, probably from inclusion of a skin nerve in the scar.

2. The second class of compound fractures, *with large wounds* of the soft parts, comprised only 2 cases. They were treated by immediate *antiseptic operation*, *débridement*, excision of devitalized tissues, fixation of the bone fragments, drainage and partial closure of the wound: in neither case could complete closure have been secured without some form of plastic operation to fill the areas of skin destroyed by the accidents; and it was believed to be a better course to allow the wounds to heal by granulation. Dependent drainage was always secured, a counteropening being made for this purpose posterior to the fibula and a drainage tube being passed across the leg at one or more points. In the first case, involving the ankle-joint (Fig. 14), the tibia was fixed by a plate and fairly accurate reduction secured (Fig. 15); but owing to rise in temperature after ten days the gypsum splints were removed, under general anesthesia, and it was then found that the plate had been pulled loose from the lower fragment of the tibia (probably during removal of the splints). The plate was therefore removed entirely and skeletal traction by the Steinmann nail applied (Fig. 16). This resulted in final union without deformity, though several sequestra were removed at another occasion and a sinus (barely moist) persists eighteen months after the accident. This patient wore a leg brace for a year after the accident, was out of work eighteen months and has no motion in his ankle-joint. He is counted as having recovered with good anatomy and moderate function (Fig. 17). In the only other case in this series, of compound fracture with much destruction of the soft parts, there was a double fracture of both tibia and fibula: the compound fracture of each bone was fixed by a removable clamp (Fig. 18) and the simple fracture of each bone disregarded, except for continuous traction by a Steinmann nail. The traction nail and the clamps were removed three

weeks after the injury, and the soft parts continued to heal uninterruptedly, though the wound was not completely closed for nearly eight months after the accident. The patient was out of work nine months and secured a moderately useful leg without shortening, but neither the functional nor the anatomical result was perfect.

Operative Treatment. Of the entire series of 152 cases (72 fractures of the shafts of the leg bones and 80 involving the ankle) operation was employed in 16 patients, 14 of whom have been traced. These 16 operations do not include the use of the Steinmann nail for traction in 10 cases, tenotomy of the tendon of Achilles in 2 cases, nor 1 case of arthrotomy of the knee-joint (with immediate closure) for hemarthrosis.

TABLE XIII.—OPERATIONS FOR FRACTURES OF TIBIA AND FIBULA

	Simple fractures:		Compound fractures:	
Site.	Total number.	Operations.	Total number.	Operations.
Leg	58	5	14	4
Ankle	79	6	1	1
Total	137	11	15	5

TABLE XIV.—OPERATIONS EMPLOYED

Operation.	Simple.	Compound.	Total
Plate	4	5	9
Screws (all ankle fractures)	6	0	6
Open reduction	1	0	1
Total	11	5	16

Except in compound fractures with great destruction of the soft parts, no immediate operations have been done, a delay of from five to ten days always having been allowed for proper sterilization of the skin. In a series of 130 operations in civil life by one of us (A.) for simple fractures of various bones in the body only one infection has occurred, and this was clearly due

to too early operation before the bullæ which followed the original injury had entirely healed.[1] Among the 9 cases in which a plate was inserted in the leg, only once has the plate had to be removed subsequently, and then only because the patient was kicked in the shin by a horse one year after the operation, the horse's kick causing a lacerated wound which exposed the plate.[2] In the tibia the plate has always been placed on its fibular surface, never subcutaneously, so as to avoid, so far as possible, any tendency toward such an accident. Of the 6 cases in which screw fixation[3] was employed for recent fractures of the ankle, the screws were removed in 1 case about a year after operation, because of persistent pain in the ankle. This patient is counted as a bad functional result. The only case in which open reduction was adopted without direct fixation of the bone, occurred in a child, the fracture resembling that shown in Fig. 1. In this case several ineffectual attempts to reduce the fragments had been made by another surgeon (under anesthesia) before the child came under our care, and the soft parts were in very bad condition, though the fracture was not compound. In such fractures as these 2 it seems to us doubtful whether any attempt at closed reduction is judicious, as we believe it will cause more injury to the soft parts (even were the efforts successful) than operation would entail.

In 78 per cent of operative reductions, anatomical reposition was secured; in 3 cases only moderately accurate reduction was secured; in no case, we believe, could as good function have been obtained without as with operation.

Conclusions. Early reduction of all gross displacement is urged, and in ankle fractures "anatomical reposition" should be the goal in view. Stimson splints of plaster of Paris are far

[1] In 1 or 2 other cases there was superficial infection of the skin at one or more points, but not extending beneath the superficial fascia.

[2] There has been recently brought to my notice a patient still carrying in his tibia a plate inserted for non-union by my father twenty-seven years ago.

[3] See Ashhurst: "Screw-fixation in Joint Fractures," Medicine and Surgery, St. Louis, October, 1917.

superior to circular cases, because permitting proper care of the soft parts at suitable intervals, preventing atrophy during the process of union, as well as stiffness and swelling during convalescence. The Delbet apparatus has certain additional advantages, notably that of allowing active motion of the knee- and ankle-joints while the fracture is uniting, as well as hastening the process of union and shortening the period of disability. In compound and in simple comminuted fractures traction by the Steinmann nail has given admirable results. If direct bone fixation is adopted in compound fractures which require immediate open reduction, the fixation apparatus should be removable as soon as fair union is secured. The period of disability for fractures of the shafts of the leg bones in this series averaged (in simple fractures) three and eight-tenths months, *nearly a month less* than the average period of disability shown by the statistics of the American Surgical Association; and in compound fractures it averaged five and a half months, or *over two months less*, than for corresponding cases tabulated by the American Surgical Association. The period of disability for ankle fractures averaged approximately the same in both series (Table X).

DISCUSSION

Dr. William L. Estes, Bethlehem, Pa.:

There is one point I want to bring up in regard to fractures which we have been able to study at our clinic. Most of the cases go back to the steel works, where a careful record is made of the time of disability and the character of the disability of the individual. We have been astonished to find in cases reported back with an average disability varying from 25 to 60 per cent that they will after a few years *entirely overcome their disability*. We have had some cases where there was a 50 per cent disability, who after two and a half years have recovered their full ability for work and were thoroughly efficient.

I think this ought to be taken into consideration, and statements in regard to disability after fracture should not finally be made immediately after the treatment has been closed.

I agree with Dr. Ashhurst that functional results certainly ought to be the indication of proper treatment of a fracture, but the possessor of the fracture does not always agree with us. Very often patients are advised by some friend to go to an *x*-ray man who does not know how to take skiagrams and the condition will be exaggerated by the *x*-ray picture and a suit may follow.

I believe we should explain to the individuals and warn them that there will not be an absolutely perfect anatomical result.

I have found also that though anatomical recoveries may be obtained by operation, the period of disability in these cases is always greater than when no operation has been done. This must also be taken into account.

Dr. Kellogg Speed, Chicago:

Clinically these cases should be divided into fractures near or into the joints and those of the shaft. There is a great difference in the type of treatment to be employed. I believe that we are treating fractures into joints much better at the present time, largely because we are using earlier motion and especially early *active* motion, and that passive motion has largely fallen into disuse. I still believe that the treatment of fractures resolves itself into immediate treatment and that the ideal treatment for fractures of both bones of the legs has not yet been devised. I have tried skeletal traction and other types of traction both on the skin and by means of the fracture table. I have tried open operation and plates and agree with Dr. Estes that the non-operative cases have a shorter period of disability.

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